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Prepared for

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16. ABSTRACT

Ambient temperatures have been reported to affect automotive emissions and fuel economies since 1966. Federal automobile emission standards and the measured fuel economies are currently based on results obtained using the 1975 Federal Test Procedure and the Highway Fuel Economy Test. Both tests must be conducted at ambient temperatures from 68°F (20°C) to 86°F (30°C). Since cars in service must start and run over a much broader temperature range than this, the U.S. Environmental Protection Agency wanted to know how well the various car age groups and emission control technologies available today would perform at the more extreme ambient temperatures using the above test procedures as well as other specialized tests. It was also desired to know how the use of a car's air conditioner would affect exhaust emissions and fuel economies.

This report presents the results of exhaust emissions (regulated and unregulated) and fuel economies associated with fourteen selected vehicles tested at ambient temperatures ranging from 0°F (-18°C) to 110°F (43°C) using the various test procedures.

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FOREWARD

Ambient temperatures have been reported to affect automotive emissions and fuel economies since 1966. Federal automobile emission standards and the measured fuel economies are currently based on results obtained using the 1975 Federal Test Procedure and the Highway Fuel Economy Test. Both tests must be conducted at ambient temperatures from 68°F (20°C) to 86°F (30°C). Since cars in service must start and run over a much broader temperature range than this, the U.S. Environmental Protection Agency wanted to know how well the various car age groups and emission control technologies available today would perform at the more extreme ambient temperatures using the above test procedures as well as other specialized tests. It was also desired to know how the use of a car's air conditioner would affect exhaust emissions and fuel economies.

This report presents the results of exhaust emissions (regulated and unregulated) and fuel economies associated with fourteen selected vehicles tested at ambient temperatures ranging from 0°F (-18°C) to 110°F (43°C) using the various test procedures.

SUMMARY

The effect of ambient temperature on exhaust gas emissions, fuel economy, catalyst light-off time,* exhaust gas temperatures, and driveability were studied using 14 automobiles at eight ambient temperatures which ranged from 0°F (-18°C) to 110°F (43°C). The vehicles consisted of groups of noncatalyst, 49 State standards, California standards, and prototype cars. The studies were conducted using the 1975 Federal Test Procedure, the Highway Fuel Economy Test, the Sulfate Emission Test, the New York City Cycle, and the Federal Short Tests.

The current automobile emission standards and the measured fuel economies are based on results from the 1975 Federal Test Procedure and the Highway Fuel Economy Test. Both tests are normally performed at temperatures from 68°F (20°C) to 86°F (30°C). The other tests used in this program were specialized tests and their test temperature limits have not been specified. The Sulfate Emission Test was used to measure the sulfate and the particulates being emitted by the various catalyst systems. The New York City Cycle, which simulates selected New York City driving conditions, was used in lieu of the Federal Short Tests for some of the cars. Some parts of the Federal Short Tests have been considered for emission measurements in inspection stations. In this program, a garage type instrument (Stewart Warner) was compared to a scientific type instrument (Beckman) using the steady state conditions of the Federal Short Tests. The two instruments did not agree on the amount of hydrocarbons in the exhaust gas but they did agree on the amount of CO present.

In addition to the regulated exhaust gas emissions (HC, CO and NOX), unregulated emissions (aldehydes, hydrogen sulfide, sulfate, particulates and individual hydrocarbons by gas chromatography) were also measured.

The results from this program showed that hydrocarbons, carbon monoxide and nitrogen oxides generally increased as the ambient temperature decreased from the normal ambient temperature limits specified for the Federal Test Procedure. The hydrocarbons and the carbon monoxide emissions

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* Catalyst light-off time is defined in this report as the time into the Federal Test Procedure at which the temperature of the exhaust gases leaving the catalyst first exceeded the temperature of the exhaust gases entering the catalyst.

were more responsive to ambient temperatures than the nitrogen oxide emissions were. The hydrocarbon and carbon monoxide variations observed at the lower temperatures using the cold transient phase of the Federal Test Procedure appeared to be a function of the emission control technology used in the vehicle. At temperatures above the normal ambient temperature, the results varied with the vehicle with some vehicles showing higher emissions.

The use of the vehicle's air conditioner usually increased the hydrocarbon, carbon monoxide, and nitrogen oxide emissions as well as the fuel consumption.

In a very few cases, hydrogen sulfide was detected in the exhaust gases using the Federal Test Procedure. The highest concentration detected was 18 mg/km and this occurred at 0°F (-18°C).

The aldehydes detected in the Federal Test Procedure composite sample showed no consistent trend with test temperature. Two of the noncatalyst cars produced the highest concentrations of aldehydes while the third noncatalyst car gave results similar to several of the catalyst equipped cars. Several of the catalyst equipped cars gave aldehyde emissions that were less than half of those emitted by the noncatalyst cars.

The sulfate produced using the Sulfate Emission Test was always very low. The noncatalyst cars gave much lower concentrations of sulfate than the catalyst cars and only the three highest emitters gave sulfate emissions greater than 1 mg/km. There was no relationship between sulfate emissions and the ambient temperature.

The particulates measured during the Sulfate Emission Tests produced a variety of results. The noncatalyst cars gave particulate emissions that varied from 6 to 32 mg/km while those of the catalyst cars ranged from 3 to 36 mg/km. Some cars gave maximum particulates at 0°F (-18°C) while others produced maximum particulates at 110°F (43°C) or intermediate temperatures.

Individual hydrocarbons and hydrocarbon groups found in the exhaust gases obtained using the Federal Test Procedure were analyzed by a gas chromatographic method. The concentrations of about seventy-five specific hydrocarbons were determined for each phase of the Federal Test Procedure at all eight ambient test temperatures. These were also grouped in terms of methane, saturates, acetylene, olefins, aromatics and unknowns. The results were quite varied. For the cold transient phase of the Federal Test Procedure, the methane concentrations varied from 2.6 to 12.9% of the hydrocarbons for the noncatalyst cars as compared with 7.4 to 36.3% for the catalyst equipped cars. For this test phase, the saturates accounted for 30 to 50% of the hydrocarbons, the acetylenes 0-15%, the olefins 6.6 to 34.7%, the aromatics 7.8 to 32.2%, and benzene 1.4 to 6.3%.

The fuel economies obtained during the cold transient phase of the Federal Test Procedure were very sensitive to ambient temperature. The poorest economies occurred at 0°F (-18°C). The use of air conditioning reduced fuel economy in nearly every case. For the stabilized and hot transient phases, the fuel economies improved substantially as compared to the cold transient phase.

The light-off times and light-off temperatures of the catalyst obtained using the cold transient phase of the Federal Test Procedure varied widely for the different catalyst systems. The light-off times for all cars with catalyst at all test temperatures varied from 67 to 419 seconds and the light-off temperatures ranged from 400 to 1100°F (204 to 593°C). There was no consistent relationship between light-off time and ambient temperature. There were larger differences in exhaust gas temperatures between catalyst systems than there were between test procedures or ambient temperatures.

A considerable number of driveability problems occurred at 0 and 20°F (-18 and -7°C) using the cold transient phase of the Federal Test Procedure. However, some driveability problems were encountered at higher ambient temperatures and with other test cycles. Driveability problems usually increased most of the exhaust gas emissions.

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LIST OF ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

AC -- Air Conditioner
API -- American Petroleum Institute
B -- Beckman Exhaust Gas Analyzer (Scientific Type)
CAL -- California
CALIF. -- California
CO -- Carbon Monoxide
CVS -- Constant Volume Sampler
dm^3 -- Decimeter Cubed or One Litre
EPA -- Environmental Protection Agency
FST -- Federal Short Tests
FTP -- Federal Test Procedure
FU-INJ -- Fuel Injection
F3M -- Federal 3 Mode
HC -- Hydrocarbon
HFET -- Highway Fuel Economy Test
H_2S -- Hydrogen Sulfide
IR -- Infrared
km/h -- Kilometers per hour
l/km -- Litres per kilometer
L/KM -- Litres per kilometer
MAX -- Maximum
MIN -- Minimum
mpg -- Miles per gallon
MPG -- Miles per gallon
mph -- Miles per hour
NOX -- Oxides of nitrogen
NYCC -- New York City Cycle
PPM -- Parts per million
rpm -- Revolutions per minute
RVP -- Reid Vapor Pressure, lbs.
SAE -- Society of Automotive Engineers
SE -- Engine oil performance rating that meets current new car warranty requirements
SET -- Sulfate Emission Test
STW -- Station Wagon
SW -- Stewart Warner Exhaust Gas Analyzer (garage type)
49S -- 49 State

SECTION 1

INTRODUCTION

Ambient temperatures have been reported to affect automotive emissions and fuel economies since 1966 (1-7)*. Federal automobile emission standards and the measured fuel economies are currently based on results obtained using the 1975 Federal Test Procedure (FTP) and the Highway Fuel Economy Test (HFET). Both tests must be performed** at ambient temperatures from 68°F (20°C) to 86°F (30°C) Since cars in service must start from and operate over a much broader temperature range than this, it was desired to identify how well the various car age groups and emission control technologies available today would perform at the more extreme ambient temperatures. It was also desired to identify how the use of a car's air conditioner would affect exhaust emissions and fuel economies.

In addition to the FTP and the HFET, other specialized tests were run at selected ambient temperatures. These were the Sulfate Emission Test (SET), the New York City Cycle (NYCC), and the Federal Short Tests (FST). The SET was used to evaluate the amount of sulfate and particulates being emitted by the various emission control systems. The NYCC, which simulates selected New York City driving, was used in place of the FST for a number of the cars. Some parts of the FST have been considered for emission measurements at inspection stations. In this regard, one garage type instrument (Stewart Warner) was compared to a scientific type instrument (Beckman) using the steady state conditions of the FST.

In this program, fourteen cars were evaluated for emissions, fuel economy, driveability, catalyst light-off time, and exhaust gas temperatures at eight controlled ambient temperatures which varied from 0°F (-18°C) to 110°F (43°C). The vehicles consisted of groups of noncatalyst, 49 State standards, California standards and prototype cars. Duplicate tests at each temperature were conducted in nearly every case. In addition to regulated emissions (HC, CO, and NOX), unregulated emissions (aldehydes, hydrogen sulfide, particulates, sulfate and individual hydrocarbons measured by means of gas chromatography) were also measured.

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*Numbers in parentheses designate references at the end of the report.

** Throughout this program, performance of a test at a specified temperature means that the vehicle was soaked at and operated over the test cycles at the specified temperature.

Catalyst light-off times and exhaust gas temperatures before and after the catalyst were measured during the FTP. Maximum and minimum exhaust gas temperatures out of the catalysts were measured during all of the test cycles but only the FTP data were plotted.

Driveability problems encountered while running the FTP were recorded nd an attempt was made to determine their influence on emissions.

SECTION 2

CONCLUSIONS

Hydrocarbon (HC) and carbon monoxide (CO) emissions were generally higher than normal at all ambient temperatures below about 60°F (16°C) for the 1975 Federal Test Procedure (FTP).

The HC and CO emissions were much more responsive to changes in the ambient temperature during the cold transient phase of the FTP than they were during the other two phases. The HC and CO emission variations observed at the lower ambient temperatures with the cold transient phase appeared to be a function of the emission equipment technology used in the vehicle.

Some very high HC and CO emissions occurred at 110°F (43°C) with some emission control equipment while running the New York City Cycle.

The use of a vehicle's air conditioner usually increased the HC, CO, and NOX emissions as well as the fuel consumption.

NOX emissions were affected by the ambient temperature but to a lesser degree than the HC and CO emissions.

Tests conducted at the lower ambient temperatures were frequently complicated by starting and driveability problems which in turn affected the emission levels.

The aldehydes detected using the FTP showed no consistent trend with ambient temperature. Two of the noncatalyst cars (1974 Chevrolet and 1978 Honda) gave the highest aldehyde concentrations with a maximum of 322 mg/km for the Honda at 20°F (-7°C). The third noncatalyst car, the 1972 Chevrolet, gave aldehyde concentrations that were similar to those obtained with some of the catalyst cars.

In a very few cases, hydrogen sulfide was detected in the exhaust gases. It was generally below detectable limits. The highest concentration detected was 18 mg/km and this occurred at 0°F (-18°C) in the 1978 Buick. The next highest level was 10 mg/km and this occurred in the same car at 110°F (43°C).

Four cars (all catalyst cars) produced sulfate emissions greater than 1 mg/km. These four cars were the 1977 California Plymouth, 1978 Chevrolet, 1979 Dodge and 1980 prototype Mercury. A maximum in one test of 23 mg/km was found in the 1978 Chevrolet at 40°F (4°C). There was no clear relationship between sulfate formation and ambient temperature.

The particulates measured during the Sulfate Emission Tests produced a variety of results. The noncatalyst cars gave particulate emissions that varied from 6 to 32 mg/km while those of the catalyst cars ranged from 3 to 36 mg/km. Some cars gave maximum particulates at 0°F (-18°C) while others produced maximum particulates at 110°F (43°C) or intermediate temperatures.

As determined by gas chromatography, the methane produced during the cold transient phase of the FTP by the noncatalyst vehicles was relatively small (2.6 to 12.9%) as compared to the catalyst equipped cars (7.4 to 36.3%).

The saturates accounted for 30 to 50% of the hydrocarbons for all cars with the cold transient phase of the FTP.

The acetylenes produced during the cold transient phase of the FTP varied from 0 to 15% for all cars with the higher concentrations occurring at the lower test temperatures.

The olefins produced by the noncatalyst cars varied from about 8 to 50% of the total hydrocarbons for all three phases of the FTP. The olefins emitted from the catalyst equipped cars were substantially lower than those obtained with the noncatalyst cars, especially after the catalysts were warmed up.

The percent aromatics found in the exhaust gas hydrocarbons from the cold transient phase of the FTP showed little effect of ambient temperature or emission control system. For the stabilized phase, the aromatics were markedly reduced by some emission control systems.

The benzene found in the exhaust gases for the FTP varied from 0% to 11% of the total hydrocarbons. During the cold transient phase of the FTP, the exhaust gases contained approximately 1 to 7% of benzene.

The fuel economies obtained by all of the cars during the cold transient phase of the FTP were very sensitive to the ambient temperature, with the poorest economies occurring at 0°F (-18°C). The use of air conditioning reduced fuel economy in nearly every case. For the stabilized phase, the fuel economy improved substantially as compared to the cold transient phase of the FTP and again raising the test temperature improved the fuel economy.

The hydrocarbon emissions measured by the Beckman and the Stewart Warner instruments during the Federal Short Tests were frequently in very poor agreement. However, the CO emissions measured by these two instruments were nearly always in good agreement.

The light-off times and the corresponding catalyst out exhaust gas temperatures during the FTP varied widely for the different catalyst systems. The light-off times for all eight ambient temperatures varied from 67 to 419 seconds and the light-off temperatures ranged from about 400 to 1100°F (204 to 593°C). There was no consistent relationship between light-off time and ambient temperature. The maximum exhaust gas temperatures measured were usually obtained during the HFET. The maximum exhaust gas temperature measured was 1,462°F (794°C). There were larger differences in exhaust gas temperatures between catalyst systems than there were between test procedures or ambient temperatures.

Most of the driveability problems were encountered during the cold transient phase of the FTP during the 0°F (-18°C) and 20°F (-7°C) ambient temperature tests. However, a considerable number of driveability problems were encountered in some cars at the higher test temperatures and during the other test phases.

Section 3

EQUIPMENT AND MATERIAL

CHASSIS DYNAMOMETER

The chassis dynamometer employed is an all-weather test facility. Material used in its construction can withstand large changes in ambient operating conditions. This facility was designed to duplicate all of the operating conditions to which a vehicle is subjected during highway operation. Vehicles as large as a Sceni-cruiser bus and as small as a compact car can be tested.

Test Cell

The room that contains the test vehicle is the only area that is heated or refrigerated. This room is 14 m (46 ft) long and 5.5 m (18 ft) wide. The chassis dynamometer test cell is shown in Figure 1.

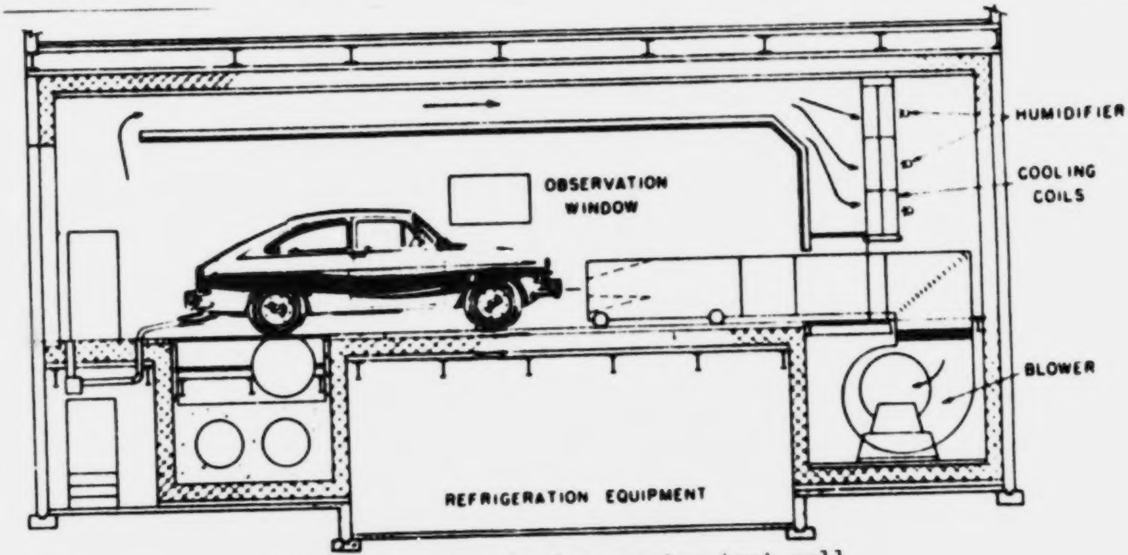

Figure 1. Chassis dynamometer test cell

Temperature and Humidity Capabilities and Recorders--

Ambient temperatures from 70°F (-56°C) to 120°F (49°C) can be maintained along with controlled humidity. Moisture is supplied to the room as steam to obtain the desired humidity. Makeup air can be passed through a drying system, if necessary, to reduce its humidity. The temperature and humidity are regulated from an exterior control panel. A thermocouple located 91 cm (3 ft) in front of the vehicle grill and 91 cm (3 ft) above the floor was used as the measurement source for the automatic temperature controller. A Honeywell Model R-15 controller and a disc-type recorder is used to control the room temperature. This controller is set to the temperature desired, and it then controls the entire refrigeration system. The disc chart records the cell temperature for 24 hours.

The humidity is also controlled at the console control panel. A Nullmatic M/P Controller is set to automatically regulate the humidity of the cell. A Dewcel sampler constantly analyzes the air and signals the Nullmatic. The dewpoint in the room is recorded on a Foxboro disc-type recorder, similar to the temperature recorder. Relative humidities from 5 to 95% can be controlled by this instrument.

Vehicle Restraints and Tread Rolls--

Both rear-wheel and front-wheel drive vehicles can be tested on this dynamometer. Concave floor blocks engage the front of the idle wheels, then adjustable saddles slide over and clamp the rear portion. The saddles are adjustable to accommodate different tire sizes, and the blocks are fastened to slide rails and are adjustable for various length wheel bases. When a test vehicle is mounted on the dynamometer, the drive wheels are positioned on top of two 122 cm (4 ft) diameter steel rolls which are 61 cm (2 ft) wide. These rolls are connected to the inertia and windage loading system in an adjacent room.

Loading System--

The road inertia of vehicles with curb weights from 907 kg (2000 lb) to 3266 kg (7200 lb) can be simulated. Four fly wheels, sized to permit an equivalent increase in inertia of 91, 181, 363, and 454 kg (200, 400, 800, 1000 lb) can be independently engaged or disengaged from the drive shaft that connects the tread rolls to a 112 kW (150 hp) motoring, 298 kW (400 hp) absorbing dynamometer. This connection is made via a three-speed gear box that can be shifted to underdrive, overdrive, direct drive, or neutral. This shift changes the inertia load of the system so that four ranges of loading are available.

The road load horsepower of a vehicle is simulated by driving a centrifugal air blower which is also coupled to the dynamometer shaft via a three-speed gear box. With blower speed flexibility in combination with an air flow damper on the fan output, road load horsepower settings can be obtained to conform to the values listed in the Federal Register (8). Additional loading can be applied electrically using the absorbing dynamometer motor. The arrangement of the dynamometer loading system is shown in Figure 2.

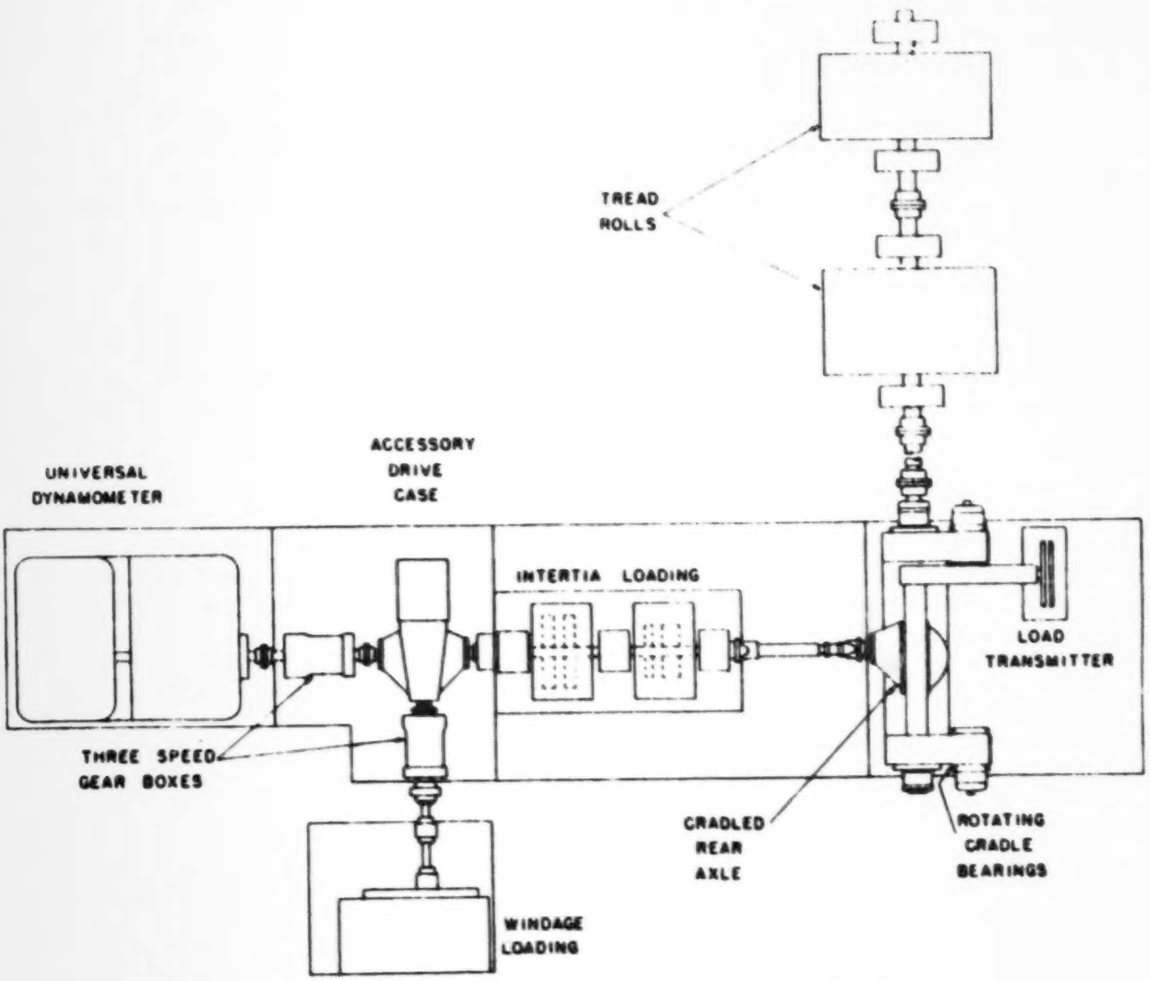
TREAD ROLLS
ACCESSORY DRIVE CASE
UNIVERSAL DYNAMOMETER
INTERTIA LOADING
LOAD TRANSMITTER
THREE SPEED GEAR BOXES
CRADLED REAR AXLE
ROTATING CRADLE BEARINGS
WINDAGE LOADING

Figure 2. Dynamometer loading system

Vehicle Cooling--

Frontal cooling is supplied from a telescoping duct 122 cm (4 ft) high and 122 cm (4 ft) wide. The duct is baffled to direct the air to the vehicle grill and undercar area. This air is recycled through the humidifier and cooling coils. A Pitot tube is mounted at the end of the duct to measure air speed. This reading is indicated on a Magnehelic gauge which is calibrated in miles per hour. Air velocity is normally matched to vehicle speed automatically, but it can be set to any constant value.

Exhaust System--

The vehicle exhaust is connected to the sampling system by a thermostatically controlled heated flexible line which is 3.7 m (12 ft) in length and 6.4 cm (2.5 in) in diameter. This insulated line is Type BCU interlocking stainless steel hose with air-tight Marmon flange connectors and is routed through the dynamometer floor to a 10.2 cm (4 in) stainless steel gate valve which directs the flow to a dilution tunnel or to a mixing chamber.

Mileage Counter and Recorder--

A revolution counter on the driveshaft of the dynamometer rolls is coupled to a digital counter and printer. The driver of the test vehicle presses a button which sends a print command to the printer when mileage is to be recorded. The mileage counter system generates 21,008 counts per mile of vehicle travel with an accuracy of 0.00016 km (0.0001 mi).

Display Panel--

A vehicle speed gauge and tractive effort gauge are mounted on a suspended portable panel in the test room. This panel straddles the car hood and is anchored just outside the windshield of the vehicle where it can be observed easily by the driver. A red flashing light is also mounted on the panel to alert the driver of any malfunctioning equipment or unsafe conditions. If any of the dynamometer safety circuits are activated, this light flashes.

Vehicle Accessories

Several items necessary for the test are transferred from vehicle to vehicle when a new test is started.

Drivers Aid--

A Hewlett-Packard Model 680 instrument, made especially for displaying and recording cyclic operation, was used for this program. Rolled charts with preprinted speed traces are displayed to the driver; and a recording pen indicator, indicating the vehicle speed, is used to follow the prescribed test cycle speeds. Charts are available for the Federal Test Procedure, Highway Fuel Economy Test, Sulfate Emission Test, Federal Short Cycle, and New York City Cycle. The last two mentioned were made with a computer plotter from data supplied by EPA. The other charts were standard purchasable items.

Tachometer and Vacuum Gauge--

At specified test times, engine rpm and manifold vacuum readings were obtained. These were observed visually and recorded manually. Engine rpm was indicated by a Snap-on Model MT 417 inductive lead pickup tachometer. Vacuum in inches of mercury was observed with a Crosby Model AAO gauge with 6.4 mm (0.25 in) subdivisions.

Temperature Measurement--

Engine coolant, crankcase oil, carburetor air, and exhaust gas temperatures were monitored with Conax premium grade ungrounded iron-constantan thermocouples mounted at their respective locations during vehicle preparation. A junction box in the test cell provides plug-in connections that lead to a temperature recorder in the sampling room.

Communications System--

To correlate the sampling procedures with the driving procedures, sound-powered microphone headsets were used. They are David Clark Model H 5040 plug-in units. Several junction boxes were mounted in the dynamometer area to provide greater versatility.

Air-Conditioning Duct--

When test runs were made at 80°F (27°C) and above, and the vehicle air conditioning system was not used, auxiliary air conditioning was supplied to the vehicle interior. This air conditioning was supplied by way of a 20.3 cm (8 in) flexible hose connected to a portable room air conditioning unit located outside the test cell.

SAMPLING EQUIPMENT

A room directly below the rear portion of the dynamometer test cell contains all of the exhaust gas sampling apparatus. A cement and tile ceiling 56 cm (22 in) thick provides insulation from the test cell area. Figure 3 is a sketch of the exhaust gas sampling system.

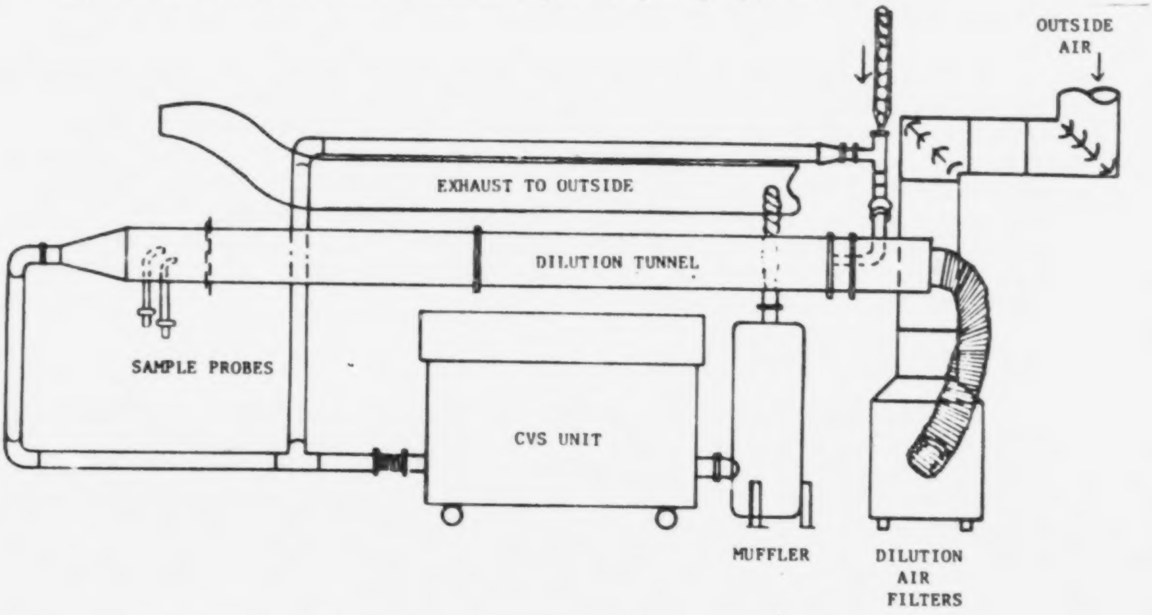

Figure 3. Exhaust gas sampling system.

Regulated Emissions

CO, CO_2, HC, and NOX are the regulated emissions sampled for analysis. A Scott Model 301 Constant Volume Sampler, employing a positive displacement pump, is used to dilute, measure, and sample the vehicle exhaust in accordance with the procedure specified in the *Federal Register*.(9) The pump capacity is approximately 141.6 dm^3/sec (300 ft^3/min). The unit utilizes an air to air heat exchanger which controls the inlet air to the displacement pump and sample bag. The sampling system was modified to add another outlet for an air bag so that simultaneous dilution air and exhaust bag samples could be obtained for each phase of the FTP. The collection bags are constructed of 0.05 mm (2 mil) Tedlar (polyvinyl flouride) enclosed within a black plastic shield to minimize photochemical reactions. They have a 120 l (4.25 ft^3) capacity. The dilution air required for the system is ducted from outside the building through an electrically heated duct and then through a three-stage air filtration system. When the outside ambient temperature is low, the air can be heated to 68°F (20°C). In the summer, tests are conducted in the morning so that ambient temperatures do not exceed 86°F (30°C). The air filtration system consists of an Aeromold filter to remove large airborne particulates, a charcoal adsorber cell to remove hydrocarbons and a fine glass fiber filter (absolute) to remove small particulates. The flow of the dilution air from the filters to the mixing tee in front of the heat exchanger is always through the dilution tunnel. With the air heated, condensation in the system when exhaust gas is admitted is minimal.

Unregulated Emissions

Dilution Tunnel--

Particulates and sulfates are sampled using a dilution tunnel 5.49 m (18 ft) long and 318 mm (12.5 in) in diameter. It is constructed of type 304 stainless steel with a wall thickness of 1.59 mm (1/16 in). A baffle plate with an opening one-half the diameter of the tunnel is mounted at the exhaust inlet location and sample probe tips are downstream 4.05 m (13.3 ft) from the baffle. The probes are 19.1 mm (0.75 in) in diameter with tips ground to a knife-edge. Two probes are mounted equidistant from the centerline of the tunnel. The filters used to collect the particulate samples are attached to the probes at their exits. The filter holders are disc-type 47 mm in-line stainless steel units made by Gelman Instrument Company. The inlets to the holders and the connecting fittings were machined to provide an unbroken interior surface from the probe tip to the filter surface area. The filters are 47 mm Fluoropore membrane discs with a pore size of 1.0 micron. The system uses a Gast rotary-vane pump capable of pulling a vacuum up to 94.6 kPa (28 in Hg) and a free flow of 0.235 m^3/min (8.3 ft^3/min). It draws the sample through the probe, filter, flowmeter, and regulating valve of two identical systems. Each flow is constantly monitored to maintain an isokinetic gas velocity through the probe and dilution tunnel. The pump discharge is routed through a variable area flow meter and into a Rockwell No. 250S bellows-type dry gas meter. The inlet temperature is monitored with an iron-constantan thermocouple, and the outlet pressure with a Dwyer Magnehelic pressure gauge. As mentioned earlier, the CVS dilution air always flows through the tunnel. The vehicle exhaust is directed either to the tunnel by a Jamesbury stainless steel wafer-sphere butterfly valve with a positive sealing seat, or to a mixing tee in front of the CVS heat exchanger.

Aldehyde and Hydrogen Sulfide Extraction Apparatus--

Two separate sample lines and systems located downstream from the positive displacement pump on the CVS unit are used to sample the diluted exhaust. Each system contains an Air Control, Inc., diaphragm pump that draws the sample through two 100 ml impingers submerged in an ice bath, a moisture trap, a Brooks flow indicator, and a regulating valve. The pump discharge is through a Rockwell 150 S bellows-type dry gas volume meter. The inlet temperature is monitored with an iron-constantan thermocouple to standardize the volume readings. The outlet of the meter is to the atmosphere, resulting in negligible pressure drop; thus, the reading is standardized using barometric pressure.

Gas Chromatography Samples--

Hydrocarbon samples which are to be analyzed by gas chromato-graphy are extracted from the CVS bag sample. A diaphragm pump is used to transfer the diluted samples from the larger sample bag to a smaller 7.07 l (0.25 ft^3) bag constructed from 0.05 mm (2 mil) Tedlar and covered with black plastic which acts as a light shield against photochemical reactions.

Temperature Recorders--

A 12-channel Leeds & Northrup Type G Speedomax Chart recorder with a range of 0°F (18°C) to 400°F (204°C) is used to obtain a record of the following temperatures: (a) test cell ambient, (b) engine water out, (c) crankcase oil, (d) carburetor air, (e) CVS gas sample, (f) dilution tunnel probes, (G) sulfate gas meter, (h) CVS room ambient, (i) dilution tunnel in, (j) aldehyde gas meter, (k) hydrogen sulfide gas meter (l) outside ambient. Each temperature was recorded on the chart every 40 seconds.

A Doric Digitrend Model 220 Recorder is used to monitor and record vehicle exhaust gas temperatures. The time between each temperature reading varied from one second to one minute.

ANALYTICAL EQUIPMENT

The regulated emission analysis equipment is located in a room adjacent to the sampling equipment. This provided an immediate analysis of the samples. The equipment used to analyze the unregulated emission samples is located in an adjacent building. The expediency of their analysis was not as critical.

Regulated Emissions

Analyzer Bench--

An analytical system complete with all of the hardware specified in the Federal Register (10) was used. The specific instruments and their ranges are:

CO - Beckman Model I.R. 315B, Dual Cell: Three Range
330 mm (13 in) cell: 0-300 ppm, 0-1500 ppm, 0-5000 ppm
6.35 mm (1/4 in) cell: 0-0.7%, 0-7.0%

CO_2 - Beckman Model I.R. 315B, Dual Cell: Single Range
6.35 mm (1/4 in) cell: 0-3%
0.79 mm (1/32 in) cell: 0-15%

HC - Beckman Model 400 Flame Ionization Detector. Three ranges:
0-10 ppm C_3, 0-100 ppm C_3, 0-1000 ppm C_3

NO/NOX - Thermo Electron Model 10A Chemiluminescent with an NOX Converter. Three ranges:

0-100 ppm NO/NOX, 0-250 ppm NO/NOX, 0-2500 ppm NO/NOX.

This bench contains a refrigeration system with traps and filters which permits the analysis of raw exhaust samples. It also is equipped with a Honeywell Model 1508 Visicorder direct writing oscillograph that simultaneously records the output of all the instruments.

Garage-Type Analyzer--

A Stewart-Warner Model 3160-A Infrared Exhaust Emission Analyzer (portable and self-contained) was used in the analysis of Federal 3-Mode raw exhaust gas samples. CO and HC were measured by the dual-beam nondispersive infrared principle. Each meter has two ranges: 0-2% and 0-10% CO; 0-400 ppm and 0-2000 ppm HC. This unit contains its own pump, filters, and traps, plus a cylinder of calibration gas to set the span of the instruments. A mechanical sample span check is included for routine calibration verification. The exhaust gas sample is obtained via a 6.35 mm (1/4 in) stainless steel tube that was routed through the heated flexible vehicle exhaust line and extended into the tailpipe approximately 30.5 cm (12 in).

Calibration Gas System--

To calibrate and span the analytical instruments, a total of forty-five gravimetric grade and twenty-six volumetric grade size A cylinders of gas were purchased from Scott Environmental Technology, Incorporated. The gravimetric grade accuracy was listed as 1% and the volumetric as 2%. The volumetric grade gases were used as daily span gases and the gravimetric grades were used to generate calibration curves. All of these gas cylinders were shipped to EPA. in Ann Arbor where they were analyzed and then sent to Gulf, along with analyses of the gases. The EPA analyses were used for the calculations. The cylinder numbers, along with both EPA. and Scott analyses, are listed in Table 1. In addition to those listed, HC-free air,40% H_2/60% He, and N_2 zero gas cylinders were purchased. Also purchased for this system were sixty-one dual-stage cylinder pressure regulators. An electronically controlled solenoid manifold system combined with these gases and regulators enabled quick selection of a calibrating gas.

Unregulated Emissions

Particulate Weighing Facility--

An air-conditioned room controlled to 40% relative humidity and an ambient temperature of 68°F (20°C) was used to stabilize and weigh the 47 mm Fluoropore filters. The scale used was a Metler Model H 51 five-place microgram balance. A chemical hood area with a desiccator and vacuum pump arrangement was used to ammoniate the filters prior to the stabilization period. Ammonium hydroxide was used for this process. Petri dishes and forceps were used to handle the filters.

Sulfate Analysis System--

An assortment of standard laboratory glassware and fittings, a technicon Auto Analyzer proportioning pump (Model 1), a Technicon Colorimeter Model 1 with a 50 mm tubular flowcell and a Bristol Company (Model 64 AT 1) roll chart recorder were used in the analysis of sulfate. The necessary chemical supplies are isopropyl alochol, ammonium sulfate crystals, Rexyn 101, barium sulfate, and distilled de-ionized water.

Aldehyde and Hydrogen Sulfide Analysis System--

Standard laboratory chemicals and equipment were used to prepare reagents for the 2,4-Dinitrophenylhydrazine method of measuring carbonyl compounds in vehicle exhaust. The resulting derivatives were measured colorimetrically by a Bausch & Lomb Model 70 Spectronic Colorimeter.

The reagent for the collection of hydrogen sulfide was an alkaline suspension of cadmium hydroxide. The collected sulfide was subsequently determined by spectrophotometric measurement using a Bausch & Lomb Model 710 Colorimeter.

Hydrocarbons by Gas Chromatography--

The chromatographic apparatus consisted of a modified Perkin-Elmer Model 900 Gas Chromatograph with a flame ionization detector and subambient temperature accessory. A heated gas sampling valve compartment and an automatic sequential timer as well as other small modifications were added to the original equipment. A heated box for sample conditioning, a Fisher Model 5000 Recorder and a Hewlett Packard Computer Model 3350 were used in the system.

TABLE 1. ANALYSIS OF GAS CYLINDERS

Gulf Cyl. No.	Cylinder No.	Analysis			$(\frac{\text{Scott-EPA}}{\text{Scott}} \times 100)$ % Difference
		Scott	EPA		
		CO - Carbon Monoxide			
16	AAL-209	45.1	43.7	PPM	3.10
17	AAL-152	89.2	87.8	PPM	1.56
18	AAL-297	134	131.4	PPM	1.94
19	AAL-171	179	176.2	PPM	1.56
20	AAL-166	223	221.5	PPM	0.67
21	AAL-151	270	268.7	PPM	0.48
22	MH-387	452	449.9	PPM	0.46
23	A-383	674	672.5	PPM	0.22
24	MH-112	900	899.1	PPM	0.10
25	XJ-6008	1120	1121.4	PPM	-0.12
26	XA-478	1350	1341.9	PPM	0.60
27	XA-1039	2250	2235.5	PPM	0.64
28	A-5372	3000	2975.8	PPM	0.80
29	A-1744	3740	3712.7	PPM	0.72
30	XJ-50452	4510	4485.8	PPM	0.53
31	MH-1974	6470	6407.8	PPM	0.96
32	A-7005	1.05	1.05	%	0.00
33	XJ-93781	2.10	2.1	%	0.00
34	A-1046	3.14	3.1	%	1.27
35	A-4621	4.17	4.2	%	-0.71
36	A-5152	5.26	5.2	%	1.14
37	A-4321	6.25	6.2	%	0.80
38	A-11427	240	236.3	PPM	1.54
43	XJ-94441	240	235.6	PPM	1.83
39	XA-715	1180	1168.7	PPM	0.95
44	XEL-26052	1180	1169.9	PPM	0.85
40	A-3169	3920	3933.4	PPM	-0.34
45	XJ-94533	3920	3943.3	PPM	-0.59
41	A-3914	5930	5879.6	PPM	0.84
46	XA-3584	5930	5893.7	PPM	0.61
42	XA-761	6.14	6.2	%	-0.97
47	A-3281	6.14	6.2	%	-0.97

(CONTINUED)

TABLE 1. (CONTINUED)

Gulf Cyl. No.	Cylinder No.	Analysis			$(\frac{\text{Scott-EPA}}{\text{Scott}} \times 100)$ % Difference
		Scott	EPA		
		CO_2 - Carbon Dioxide			
48	XA-890	4490.0	4489.0	PPM	0.02
49	-974	8970.0	8968.1	PPM	0.02
50	-3758	1.34	1.35	%	-0.74
51	A-9837	1.81	1.81	%	0.00
52	XA-3105	2.25	2.25	%	0.00
53	XJ-60165	2.70	2.72	%	-0.74
54	A-4936	4.46	4.47	%	-0.22
55	XJ-46714	6.74	6.74	%	0.00
56	XJ-93787	8.93	8.95	%	-0.22
57	A-10779	11.3	11.3	%	0.00
58	A-3253	13.3	13.3	%	0.00
59	A-4407	2.35	2.36	%	-0.42
61	XA-739	2.35	2.35	%	0.00
60	A-3448	12.30	12.17	%	1.05
62	XJ-94509	12.30	12.16	%	1.13
		NO - Nitric Oxide			
63	A-4611	50.0	51.2	PPM	-2.40
83	XA-2351	99.4	99.3	PPM	0.10
64	A-4123	249.0	254.5	PPM	-2.20
65	A-6670	1240	1243.1	PPM	-0.25
66	A-3797	2510	2479.6	PPM	1.21
67	A-3763	83.5	83.6	PPM	-0.11
69	A-5790	80.9	78.4	PPM	3.09
68	A-3292	2040	2081.9	PPM	-2.05
70	A-5098 or 89	2020	2064.7	PPM	-2.21
84	A-3734	206	209	PPM	-1.45
85	XA-1244	208	210.7	PPM	-1.29

(CONTINUED)

TABLE 1. (CONTINUED)

Gulf Cyl. No.	Cylinder No.	Analysis			$\left(\frac{\text{Scott-EPA}}{\text{Scott}} \times 100\right)$
		Scott	EPA		% Difference
		HC - Hydrocarbon as Propane			
71	XA-2141	5.0	5.0	PPM	0.00
72	A-4988	10.0	10.0	PPM	0.00
73	XA-2367	50.1	51.1	PPM	-1.99
74	A-5811	99.4	98.1	PPM	1.30
75	A-4970	502	506	PPM	-0.79
76	A-4955	991	995.2	PPM	-0.42
77	MH-2153	8.06	8.3	PPM	-2.97
80	XA-4575	8.04	8.3	PPM	-3.23
78	XEL-33077	80.3	80.3	PPM	0.00
81	XA-1313	80.3	80.4	PPM	-0.12
79	A-2417	826	755.9	PPM	8.48
82	A-4904	826	758.4	PPM	8.18

TEST VEHICLES

A total of 14 vehicles were tested. Three were noncatalyst cars: a 1972 Chevrolet, a 1974 Chevrolet, and a 1977 Honda Civic. Three were 49 state standards: a 1977 Ford, a 1977 Plymouth, and a 1978 Buick. Five were California standards: a 1977 Plymouth, a 1977 Chevrolet station wagon, a 1978 Ford, a 1978 VW Rabbit, and a 1979 Dodge. Three were prototype vehicles: a 1980 Mercury, a 1980 Buick, and a Datsun. The prototype cars and the 1979 Dodge were supplied by EPA. All other vehicles were company-owned or rented. A more complete description of these vehicles is shown in Table 2.

FUELS AND LUBRICANTS

Two grades of unleaded fuel were blended from commercial unleaded base gasoline having an intermediate volatility. To make the summer grade fuel, that was used for tests at 60°F (16°C) and above, a standard low volatility reference fuel made from reformate and alkylate was added as needed to obtain the desired Reid vapor pressure. To make the winter grade fuel, used at 40°F (4°C) and below, butane was added to the base fuel. These fuels were used in all vehicles, including the noncatalyst cars.

TABLE 2 - DESCRIPTION OF VEHICLES

VEHICLE: Make	CHEVROLET	CHEVROLET	HONDA	FORD	PLYMOUTH
Model	Impala	Impala	Civic	LTD	Fury
Model Year	1972	1974	1977	1977	1977
Odometer, km (mi)	104,948 (65,212)	47,641 (29,603)	26,261 (16,318)	10,536 (6,547)	15,335 (9,529)
Emission Standard	Federal	Federal	Federal	Federal	Federal
Emission Control	Tuned engine	Tuned engine	Stratified Charge	EGR, Monolith Cat.	EGR, Monolith Cat.
Engine: Configuration	V-8	V-8	4 cyl.	V-8	V-8
Displacement	5.7 liter	5.7 liter	1.5 liter	5.7 liter	5.7 liter
Distributor No.	1112005-2E1	1112844-3G31	D 410-84	98-D7AE KA 6M15	3874908
Fuel System	Carb. 2 bbl	Carb. 2 bbl	Carb. 2 bbl	Carb. 2 bbl	Carb. 2 bbl
Carburetor No.	132 2DD	236 3CM	CA 120002159	D7DE-RB-J-7819	2936760
Transmission Type	Automatic	Automatic	Automatic	Automatic	Automatic
Axle: Ratio	2.74:1	3.10:1	--	2.45:1	2.70:1
Number	NA	KCB 24941	NA	WER-AA6MC	2996
Tires: Manufacturer	General	Firestone	Bridgestone	Goodyear	Goodyear
Construction	Radial	Radial	Belted	Radial	Belted
Size	GR 70-15	G75-15	6.15-13	HR75-15	F78-15
Air Conditioning	Yes	No	No	Yes	No
Vehicle Weight, kg (lb)	1932 (4260)	1941 (4280)	898 (1980)	2013 (4440)	1814 (4000)
Inertia Weight, kg (lb)	2043 (4505)	2043 (4505)	1032 (2275)	2134 (4705)	1953 (4305)
Road Load @ 50 mph, kw (hp)	9.99 (13.4)	9.47 (12.7)	6.41 (8.6)	9.99 (13.4)	9.47 (12.7)

VEHICLE: Make	BUICK (TURBOCHARGED)	PLYMOUTH	CHEVROLET	FORD	VW
Model	Regal	Fury	Impala Station Wagon	Pinto	Rabbit
Model Year	1978	1977	1978	1978	1978
Odometer, km (mi)	4,464 (2,774)	5,948 (3,696)	4,894 (3,041)	5,485 (3,408)	8,999) (5,592)
Emission Standard	Federal	California	California	California	California
Emission Control	EGR, Catalyst, Air	EGR, Monolith Cat.	EGR, Pelleted Cat.	EGR, 3-Way Cat. Air Inj.	Catalyst, EGR
Engine: Configuration	V-6	V-8	V-8	Inline 4	Inline 4
Displacement	3.8 liter	5.2 liter	5.7 liter	2.3 liter	1.5 liter
Distributor No.	1110722	3874913	1103285	12127-CA-86-29	049 905 205A
Fuel System	Carb. 4 bbl	Carb. 2 bbl	Carb. 2 bbl	Carb. 2 bbl	Fuel Injection
Carburetor No.	Dual Jet 210	0287730	6458JT	D 8EE-HA	NA
Transmission Type	Automatic	Automatic	Automatic	Automatic	Automatic
Axle: Ratio	2.66:1	2.70:1	2.56:1	3.15:1	---
Number	2AB0 072 249	NA	2YD P048N	WGF-K-8CE	NA
Tires: Manufacturer	B. F. Goodrich	Goodyear	Firestone	Goodyear	Continental
Construction	Radial	Radial	Radial	Belted	Radial
Size	P205-70R14	GR78-15	HR78-15	A78-13	155SR-13
Air Conditioning	Yes	Yes	Yes	Yes	No
Vehicle Weight, kg (lb)	2416 (3240)	1814 (4000)	1887 (4160)	1230 (2800)	953 (2100)
Inertia Weight, kg (lb)	2554 (3425)	1953 (4305)	1953 (4305)	1395 (3075)	1123 (2475)
Road Load @ 50 mph, kw (hp)	8.5 (11.4)	9.47 (12.7)	9.47 (127)	7.68 (10.3)	7.01 (9.4)

VEHICLE: Make	DODGE	MERCURY	BUICK	DATSUN
Model	Aspen	Cougar	Regal	
Model Year	1979	1980 Prototype	1980 Prototype	- Prototype
Odometer, km (mi)	7,050 (4,381)	6,190 (3,846)	23,905 (14,854)	13,390 (8,320)
Emission Standard	California	Future	Future	Future
Emission Control	Air, EGR, Reducing + Oxidizing Cat., Air Inj.	EGR, Dual 3-Way + Oxidizing Cat., Air Inj.	EGR, 3-Way Cat.	Air, EGR, Cat.
Engine: Configuration	V-6	V-8	V-6	4 Cyl.
Displacement	3.69 liter	5.7 liter	3.8 liter	1.95 liter
Distributor No.	NA	1217-AA-7K19	NA	TCD XA18 71003
Fuel System	Carb. 1 bbl	Centralized Fuel Inj.	Carb. Dual Jet	Carb. 1 bbl
Carburetor No.	8286-1718	Ethoh #138	3217 BLS	X101-711-10
Transmission Type	Automatic	Automatic	Automatic	Manual 5 Speed
Axle: Ratio	3.22:1	2.27:1	2.75:1	3.55:1
Number	1678	NA	2AB03.43	ICB-0119
Tires: Manufacturer	General	Firestone	Uniroyal	Toyo Z
Construction	Belted	Radial	Radial	Steel Radial
Size	D78-14	HR78-14	P195-75R14	165-SR-13
Air Conditioning	Yes	Yes	Yes	Yes
Vehicle Weight, kg (lb)	1442 (3180)	1860 (4100)	1470 (3240)	1111 (2450)
Inertia Weight, kg (lb)	1554 (3425)	1953 (4305)	1644 (3625)	1213 (2675)
Road Load @ 50 mph, kw (hp)	8.35 (11.2)	9.47 (12.7)	8.35 (11.2)	7.08 (9.5)

This program specified a fuel sulfur content of 0.03% or 300 ppm. Ditertiary butyl disulfide was added to give the correct sulfur concentration. Table 3 contains the essential fuel inspection data.

TABLE 3. TEST FUEL COMPOSITION

	Summer	Winter	Preconditioning
Gravity, °API, D 287	61.4	68.6	65.7
Carbon, wt %	86.09	85.34	85.68
Hydrogen, wt %	13.91	14.66	14.32
Sulfur, ppm	309	294	301
Hydrocarbon Analysis, D 1319:			
Aromatics, % vol	15.0	11.5	13.0
Olefins, % Vol	10.5	13.0	15.5
Saturates, % Vol	74.5	75.5	71.5
Benzene, % Vol	0.3	0.2	0.2
Octane Number:			
Research D 2699	91.8	91.8	92.6
Motor D 2700	84.2	84.5	83.8
Antiknock Compound:			
As Pb by D 3237 gm/gal	<0.005	0.018	<0.005
As Mn by AA gm/gal	0	0	0
Vapor Pressure, Reid, D 325, lb	8.4	12.0	11.1
Distillation, D 86:			
Over Point, °F (°C)	94 (35)	77 (25)	83 (28)
50% Point, °F (°C)	232 (111)	200 (93)	200 (93)
End Point. °F (°C)	383 (195)	298 (203)	426 (219)
% @ 158°F (70°C)	9	30	32

The crankcase oil used in all tests was a premium commercial SAE 10W40, API Service SE.

Section 4

TEST PROCEDURES

FACILITY VERIFICATION

Before carrying out the program, a series of tests were conducted to demonstrate the equipment's capability and to verify that the required test conditions could be met.

Exhaust Temperature-Road vs. Dynamometer

Thermocouples were attached to the exhaust system of a catalyst equipped vehicle (1977 Chevrolet, Test Car No. 2539) to measure four exhaust pipe skin temperatures. These four locations were: (1) directly in front of the catalyst, (2) just behind the catalyst, (3) just in front of the rear wheels, and (4) 23 cm (9 in) from the end of the exhaust pipe. The vehicle was then operated on a level road at low ambient temperatures and low humidity conditions until the exhaust pipe temperatures stabilized. These temperatures were recorded and then the vehicle was operated in the test cell under the same road load and ambient conditions, and the temperatures at the same exhaust pipe locations were recorded. These data are presented in Tables 4 and 5.

It was established that to obtain data comparable to that on the road, the car not only had to be driven on the dynamometer at the same conditions, but also had to go through a similar operating cycle. When this was done, the dynamometer results were in good agreement with results on the road. The one exception was the thermocouple located close to the end of the tailpipe. Since the tailpipe was attached to a flex tubing to dispose of the exhaust gases, it was believed that this may have increased the temperature at this point. However, the temperature was close enough to be considered satisfactory from an exhaust gas reaction viewpoint.

Ambient Temperature & Humidity Capability - Exhaust Emission Sampling and Analysis Verification

Ten test runs were made on a 1975 Ford Torino at temperatures of 0, 40, 80, and 110°F (-18, 4, 27, and 43°C). It was demonstrated to EPA's satisfaction that this vehicle could be driven and tested satisfactorily at these extreme conditions using the specified test procedures. The required tolerance for 40°F (4°C) and below was ±4°F (±2°C); for temperatures above that level the tolerance was ±2°F (±1°C). It was not possible to

TABLE 4. EXHAUST PIPE TEMPERATURE STUDIES - FIELD DATA

	Temperatures: °F				
Thermocouple:	No. 1	No. 2	No. 3	No. 4	Ambient Air: °F
	CONDITION - IDLE				
1st Run	483°	500°	316°	133°	33
2nd Run	433°	466°	350°	216°	32
3rd Run	516°	533°	375°	250°	32
X̄	477	500	347	233	32
Range	83	67	59	34	
X̄ ±10%	430 - 525	450 - 550	312 - 382	210 - 256	
	CONDITION - 20 MPH				
1st Run	433°	466°	316°	183°	32
2nd Run	400°	483°	333°	216°	32
3rd Run	433°	466°	333°	216°	32
X̄	422	472	327	205	32
Range	33	17	17	33	
X̄ ±10%	380 - 464	425 - 519	295 - 360	185 - 226	
	CONDITION - 40 MPH				
1st Run	400°	500°	350°	233°	32
2nd Run	433°	483°	350°	233°	32
3rd Run	416°	483°	350°	250°	32
X̄	416	489	350	239	32
Range	33	17	0	17	
X̄ ±10%	375 - 458	440 - 538	315 - 385	215 - 263	
	CONDITION - 55 MPH				
1st Run	500°	550°	416°	283°	32
2nd Run	466°	561°	416°	316°	32
3rd Run	500°	549°	416°	316°	32
X̄	489	553	416	305	32
Range	34	12	0	33	
X̄ ±10%	440 - 538	498 - 609	375 - 458	275 - 336	

*Outlier, data discarded.

TABLE 5. EXHAUST PIPE TEMPERATURE STUDIES - DYNAMOMETER DATA

	Temperatures, °F				
Thermocouple:	No. 1	No. 2	No. 3	No. 4	Ambient Air
CONDITION -- IDLE					
1st Run	449	513	347	261	32.0
2nd Run	469	481	334	263	31.3
Average	459	497	341	262	32
Road Values $\bar{X}$ ±10%	430-525	450-550	312-382	210-256	32
CONDITION -- 20 MPH					
1st Pass	415	-	-	-	30.7
2nd Pass	-	475	-	-	31.1
3rd Pass	-	-	300	-	31.1
4th Pass	-	-	-	328	31.0
				Avg.	31
Road Values $\bar{X}$ ±10%	380-464	425-519	295-360	185-226	32
CONDITION -- 40 MPH					
1st Pass	462	-	-	-	32.0
2nd Pass	-	505	-	-	31.7
3rd Pass	-	-	350	-	31.6
4th Pass	-	-	-	285	31.6
				Avg.	32
Road Values $\bar{X}$ ±10%	375-458	440-538	315-385	215-263	32
CONDITION -- 50 MPH					
1st Pass	500	-	-	-	32.2
2nd Pass	-	601	-	-	32.5
3rd Pass	-	-	433	-	32.2
4th Pass	-	-	-	348	31.6
				Avg.	32
Road Values $\bar{X}$ ±10%	440-538	498-609	375-458	275-336	32

control humidity at 50% relative at 40°F (4°C) and below. However, the absolute humidity at temperatures below 40°F (4°C) is so low that it cannot have much effect on emissions.

Vehicle Exchange Data--

This 1975 Ford Torino was shipped to the EPA in Ann Arbor for an exhaust emission test. Their data were obtained using a Clayton dynamometer with the car hood open at an ambient temperature of 75°F (24°C). The cooling air was constant at 25 dm^3/sec (53 cfm) and the vehicle air conditioner was on. For these comparison tests, we ran the chassis dynamometer under the same conditions and then ran another set with the hood closed and cooling air varied with car speed. The FTP and HFET procedures were run at both labs at an ambient temperature of 75°F (24°C). The results, summarized in Table 6 were considered satisfactory.

TABLE 6. EXHAUST EMISSION COMPARISON

			Gulf - open hood	Gulf - closed hood	EPA - open hood
FTP Bag 1	HC	g/km	0.99	0.93	0.71
	CO	g/km	27.38	24.19	22.24
	NOXC	g/km	1.09	1.18	0.99
	CO_2	g/km	512.96	512.12	482.60
	km/l		4.19	4.24	4.51
FTP Bag 2	HC	g/km	0.29	0.33	0.25
	CO	g/km	7.07	6.71	8.14
	NOXC	g/km	0.88	0.89	0.81
	CO_2	g/km	534.26	524.08	524.22
	km/l		4.29	4.37	4.38
FTP Bag 3	HC	g/km	0.32	0.45	0.28
	CO	g/km	12.59	12.66	13.60
	NOXC	g/km	1.36	1.30	1.24
	CO_2	g/km	450.93	431.61	418.60
	km/l		4.97	5.17	5.31
HFET	HC	g/km	0.14	0.19	0.54
	CO	g/km	4.64	4.93	19.00
	NOXC	g/km	1.57	1.54	1.34
	CO_2	g/km	334.16	333.54	291.93
	km/l		6.85	6.86	7.25

Coast-down times at two speed regimes for the Gulf chassis dynamometer and the EPA Clayton dynamometer were also measured using the 1975 Ford Torino. The averages of these times are listed in Table 7. The results showed that the Gulf dynamometer coast-down time was a little slower at

TABLE 7. DYNAMOMETER COAST DOWN TIME COMPARISON

	Gulf Time, Sec.	EPA Time, Sec.
88 to 72 km/h (55 to 45 mph) AC Off	8.05	7.86
48 to 32 km/h (30 to 20 mph) AC Off	61.83	64.14
88 to 72 km/h (55 to 45 mph) AC On	7.30	7.14
48 to 32 km/h (30 to 20 mph) AC On	32.96	35.25

80 km/h (50 mph), but a little faster at 40 km/h (25 mph). This offset, along with the small differences in fuel economy noted in Table 6, suggests that there may be a slight difference in the loading characteristics of the two types of dynamometers. This small difference was not considered to be significant for the comparisons that were to be made in this program.

Gulf/EPA Gas Cylinder Exchange Data--

Eleven Size C compressed gas cylinders, with contents unknown to us, were supplied by EPA for analysis with our analytical bench instruments. Two of these cylinders contained three-component gas blends while the others were single components with the balance being nitrogen. Our results compared favorably with the EPA analyses. The data are listed in Table 8.

TABLE 8. COMPRESSED GAS CYLINDER EXCHANGE DATA

Cylinder No.	Component	Gulf	EPA
13378	C_3H_8	17.46 ppm	16.94 ppm
14974	C_3H_8	9.66 ppm	9.81 ppm
12137	CO	2140 ppm	2109 ppm
D-1142	NOX	112.64 ppm	115.95 ppm
D-1153	NOX	74.83 ppm	74.97 ppm
D-1157	NOX	10.06 ppm	10.91 ppm
14939	CO_2	2.37 %	2.38 %
12346	CO_2	1.69 %	1.68 %
13357	CO_2	1.41 %	1.38 %
Blend "B"	C_3H_8	7.48 ppm	7.59 ppm
	CO	405 ppm	401 ppm
	CO_2	1.14 %	1.13 %
Blend "C"	C_3H_8	7.48 ppm	7.59 ppm
	CO	1020 ppm	1008 ppm
	CO_2	1.55 %	1.53 %

Scott Cross Reference Exchange Data--

Gulf subscribes to a cross reference service provided by Scott Environmental Technology, Inc. Each quarter Scott sends a compressed gas cylinder to be analyzed for C_3H_8, CO_2, CO, and NO-NOX. This service provides an accurate check of the analytical bench instruments. Between 20 and 40 participants receive these exchange samples and report their analyses. Scott tabulates the data and distributes to the participants quarterly reports containing statistical analyses of results and listing individual results. Table 9 is a tabulation of results obtained using the instruments in service for this contract. Our analyses have been well within acceptable limits.

TABLE 9. GULF AND INDUSTRY DATA ON SCOTT EXCHANGE SAMPLES

		Gulf	Industry Avg.	Std. Dev.	Gulf	Industry Avg.	Std. Dev.
		1977 - Sample 3			1977 - Sample 4		
C_3H_8	ppm	131.5	131.6	3.05	40.8	40.3	0.8
CO	ppm	1800	1835	39	246	251.5	9.3
CO_2	%	3.89	3.96	.07	2.23	2.21	0.01
NO	ppm	1893	1915	54	147.6	146.5	6.9
NOX	ppm	1908	1932	79	149.8	148.2	6.9
		1978 - Sample 1			1978 - Sample 2		
C_3H_8	ppm	8.17	8.10	0.43	876	900	28
CO	ppm	1210	1204	32.7	923	903	11
CO_2	%	1.11	1.09	0.02	2.71	2.71	0.04
NO	ppm	934.5	940.1	24.5	82.1	81.2	4.8
NOX	ppm	939.0	945.1	29.3	82.3	82.1	6.0
		1978 - Sample 3			1978 - Sample 4		
C_3H_8	ppm	91.01	90.67	2.06	17.3	17.3	0.82
CO	ppm	627	617	17	152.0	156.5	5.0
CO_2	%	3.61	3.62	0.09	0.86	0.86	0.03
NO	ppm	1246	1254	32.5	440.9	437.8	11.6
NOX	ppm	1249	1262	40.9	441.8	441.7	13.9

Gulf and EPA Sulfate Exchange--

Another cooperative program was conducted with EPA to evaluate the sulfate analysis procedure. Six sulfate extract exchange samples were analyzed by Gulf and by EPA. The results shown in Table 10 indicate that the laboratories agreed very well.

TABLE 10. SULFATE ANALYSIS COMPARISON

Sample No.		Sulfates, ug/Samples	
		Gulf	EPA
I-4		227*	--
I-8		464	--
	Avg.	464	Avg. 464
II-2		120	--
II-8		121	--
	Avg.	121	Avg. 121
III-1		48	--
III-2		52	--
	Avg.	50	Avg. 51

* Outlier

OPERATIONAL

The following describes the operational procedure followed with each vehicle.

Vehicle Preparation

When new cars were used, they were operated in normal over-the-road service for approximately 6500 km (4000 mi) to break in and condition the engine. Rented or borrowed cars had already been driven in this manner. The vehicles were then inspected for both tire and exhaust system condition. A record was made of the car's odometer, the serial numbers of the carburetor, distributor, transmission, and rear axle. The rear axle ratio was measured and the emission control system was described. Any defective parts were replaced. The cars were then weighed with fuel tanks adjusted to one-fourth full. A Marmon flange was attached to the tailpipe to provide a sealed connection to the exhaust system. Driving wheel tire pressures were adjusted to 310 kPa (45 psi) and their description recorded. Spark plugs, points, condensers, fuel filters, air filters, and PCV valves were replaced on the older vehicles and replaced, if needed, on new cars. Ignition timing, emission controls, carburetor, and choke settings were all adjusted after previously checking in the "as received" condition. No adjustments were made on the prototype vehicles or the 1979 Dodge Aspen. The engine oil and oil filters were changed except for the prototype Mercury and Buick. The battery condition and antifreeze were checked to ensure proper operation at cold temperatures. The air conditioning systems were checked for proper operation. The fuel tanks were drained, flushed, and filled with the preconditioning fuel.

Instrumentation of the cars consisted of installing thermocouples to measure water jacket, carburetor air, engine oil and exhaust temperatures. The water jacket thermocouples were usually installed at the location of the manufacturer's temperature sending unit. In the case of the prototypes, we were requested not to disturb these fittings so a wire thermocouple was slid under the bypass hose and clamped into the coolant stream. The oil temperature was measured by a sealed dipstick thermocouple the same length as the dip-stick and installed in the dipstick access hole. The carburetor inlet air temperature was measured at the inlet port of the air cleaner. Except for the prototype vehicles and the 1979 Dodge, the exhaust gas thermocouples were installed in the exhaust stream through airtight gas taps. On catalyst equipped cars, thermocouples were installed approximately 5 cm (2 in) ahead of and behind the catalyst. If more than one catalyst was used, before and after thermocouples were installed for each catalyst. On noncatalyst cars, only one thermocouple was installed 50 cm (20 in) downstream from the exhaust manifold junction with the tailpipe. With the prototype cars and the 1979 Dodge, we were not permitted to drill holes in the exhaust system. In these cases outside surface-mounted thermocouples were installed at the selected locations, and skin temperatures, not the exhaust gas temperatures, were measured.

Vehicle Preconditioning

All of the vehicles except the prototypes and the 1979 Dodge Aspen were preconditioned by being driven for 1600 km (1000 mi) on a Clayton dynamometer. The preconditioning fuel containing 0.03% sulfur was used for conducting the EPA Durability Driving Schedule (11). Cycle control was established by using tape recorded audible instructions to the driver. The prototype 1980 Mercury and 1980 Buick vehicles were each given a 160 km (100 m) preconditioning run and the prototype Datsun and 1979 Dodge Aspen were each given a 400 km (250 mi) preconditioning run. After preconditioning, the cars were moved to the test cell and mounted on the chassis dynamometer for testing.

Driving Cycles

Initially, four different driving cycles were involved in the testing sequence. After the first six cars, the New York City Cycle replaced the Federal Short Tests.

Federal Test Procedure--

The EPA Urban Dynamometer Driving Schedule published in the Federal Register (12) was used as the Federal Test Procedure at each test temperature. It is of 1371 sec. duration and the distance traveled is 12.1 km (7.5 mi). After a ten-minute soak period, the first 505 seconds of the schedule is repeated for a total traveled distance of 17.86 km (11.10 mi).

Highway Fuel Economy Test--

This driving schedule also appears in the Federal Register (13), and it was used at each test condition. It was not preceded by a conditioning run but followed either the Federal Test Procedure or the Sulfate Emission Test. Total sampling time is 765 seconds and distance traveled is 16.48 km (10.24 mi).

Sulfate Emission Test--

Labeled the EPA Congested Freeway Driving Schedule, this cycle is 1398 seconds in duration and the distance traveled is 21.72 km (13.50 mi). When it was run in the testing sequence, it followed the Federal Test Procedure.

Federal Short Tests--

These tests consisted of a Federal Short Cycle (FSC), Federal 3 Mode (F3M), and a 2500 RPM unloaded test. The FSC is a nine-mode test of 125 second duration with a distance traveled of 1.21 km (0.75 mi) as shown in Table 11.

TABLE 11. FEDERAL SHORT CYCLE DRIVING SCHEDULE

Mode*	Time in Mode (secs)
0-26 km/h (0-16 mph) acceleration	6
26-47 km/h (16-29 mph) acceleration	23
47 km/h (29 mph) cruise	10
47-60 km/h (29-37 mph) acceleration	18
60-68 km/h (37-42 mph) acceleration	4.5
68-60 km/h (42-37 mph) deceleration	2.5
60-32 km/h (37-20 mph) deceleration	32
32-0 km/h (20-0 mph) deceleration	7.5
idle	21.5
Total	125.0 seconds

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* The dynamometer loadings and transmission shift points follow the procedure as required for the 75 FTP.

The F3M consists of 80 km/h (50 mph) and 48 km/h (30 mph) steady-state cruises with the dynamometer loaded to simulate the average power which occurs at the respective speeds of the 1975 FTP as shown in Table 12. The dynamometer inertia weights are disengaged. The third mode of the F3M is conducted at idle with the automatic transmission in neutral and then in drive. The vehicle is operated in each mode for approximately one minute until the emissions stabilize. At test temperatures of 90°F (32°C) and above, it is necessary to turn on the cooling fan to prevent the engine from overheating. The hoods of the vehicles remained closed for all tests.

TABLE 12. FEDERAL 3 MODE OPERATING CONDITIONS

		High Speed Mode		Low Speed Mode		
Vehicle Inertia Weight Class	Transmission Range	Speed mph	Load hp	Speed mph	Load hp	Idle Mode
Up to 2500 lb	In drive or lower gear for 30 mph test	50	21	30	9	Automatic transmission in neutral and in drive
2501 to 3500 lb	In drive or high gear	50	26	30	12	
3501 to 3500 lb	In drive or high gear	50	31	30	15	
Above 4501 lb	In drive or high gear	50	36	30	18	

The 2500 rpm unloaded test was run with the transmission in neutral and the throttle held open to hold the engine at 2500 ±100 rpm until an exhaust sample was taken. The engine was then idled at closed throttle in neutral for another exhaust sample reading.

New York City Cycle--

Starting with the seventh car, the Federal Short Tests were replaced by the New York City Cycle (NYCC). This cycle is 599 seconds in duration and a distance of 1.90 km (1.18 mi) is traveled. The average speed is 11.41 km/h (7.08 mph) with a maximum speed of 44.6 km/h (27.7 mph). The driving schedule was provided by the EPA. The driving charts for the driver's aid were made using a computer plotter.

Temperature Sequence and Tests Required

Replicate valid tests were conducted with each car at each test temperature. Cars equipped with air conditioning had replicate valid tests run at 80, 90, and 110°F (27, 32, and 43°C) with the vehicle air conditioner in operation and set to deliver maximum cooling. Vehicles are numbered in the order of testing. Cars 1 through 7 and 10 through 14 followed a schedule outlined in the original scope of work, but the NYCC was run in place of the Federal Short Tests in cars 7 through 14. Cars 8 and 9 were requested to have a varying schedule due to program goals and vehicle availability. These schedules are listed in Tables 13 and 14.

TABLE 13. TEMPERATURE SEQUENCE & TEST CYCLES FOR CARS 1-7, & 10-14

Temp. °F	(°C)	75 FTP	SET	HFET	(Cars 1-6) FST	(Cars 7, 10-14) NYCC
60	(16)	X	-	X	-	X
70	(21)	X	-	X	-	-
80	(27)	X	X	X	X	X
80 AC	(27)	X	X	X	-	X
90	(32)	X	-	X	-	-
90 AC	(32)	X	-	X	-	-
110	(43)	X	X	X	X	X
110 AC	(43)	X	X	X	-	X
110 AC	(43)	X	X	X	-	X
110	(43)	X	X	X	X	X
90 AC	(32)	X	-	X	-	-
90	(32)	X	-	X	-	-
80 AC	(27)	X	X	X	-	X
80	(27)	X	X	X	X	X
70	(21)	X	-	X	-	-
60	(16)	X	-	X	-	X
40	(4)	X	X	X	X	-
20	(-7)	X	-	X	-	X
0	(-18)	X	X	X	X	-
0	(-18)	X	X	X	X	-
20	(-7)	X	-	X	-	X
40	(4)	X	X	X	X	-

X = test run
- = test not run

TABLE 14. TEMPERATURE SEQUENCE AND TEST CYCLES FOR CARS 8 AND 9

Temp. °F (°C)	75 FTP	SET	HFET	NYCC
40 (4)	X	X	X	-
20 (-7)	X	-	X	X
20 (-7)	X	-	X	X
90 (32)	X	-	X	-
90 AC (32)	X	-	X	-
110 (43)	X	X	X	X
110 AC (43)	X	X	X	X
110 AC (43)	X	X	X	X
110 (43)	X	X	X	X
80 (27)	X	X	X	X
80 AC (27)	X	X	X	X
70 (21)	X	-	X	-
60 (16)	X	-	X	X
70 (21)	X	-	X	-
80 (27)	X	X	X	X

When fuel changes were made, the cars were removed from the test cell, the fuel tanks drained and flushed, and then filled with the next test fuel and again placed on the dynamometer. Two FTP test cycles were driven to condition the vehicle when fuel was changed or added or when there was a shutdown of 36 hours or more. In normal operation, the regular testing sequence constituted the conditioning for the next day's run. Any tests that were declared void were repeated in their entirety. The speed/time tolerances listed in the Federal Register (14) were adhered to for all testing. If any of the tests within a test set were completed satisfactorily, the data were reported. Only one set of tests was conducted daily resulting in a soak period from 20 to 24 hours.

Deviations from Federal Test Procedures

For this entire program, four variances from the regulated procedures were in effect. These are: the evaporative emission test normally conducted with the FTP was omitted; the hoods of the cars were closed and the cooling air was matched to the vehicle speed; the 10% road load increment for AC equipped cars was not used; and in addition to humidity-corrected NOX (NOXC), measured NOX was reported.

Calibrations

Before the test vehicle was placed on the dynamometer, the inertia weights, road load horsepower at 80 km/h (50 mph) and the loaded horsepower required for the Federal 3 Mode test were determined. The corresponding dynamometer settings were made and calibrations performed with the torque system and dynamometer coast down procedure. All of the analytical instruments and the CVS unit were calibrated using the Federal Register procedures (15).

Daily Test Operation

The test cell temperatures and the humidities for the previous 12-hour period were checked to be sure they were within limits before testing began. The sequence of procedures used varied in a specific manner given in Tables 13 and 14. If a certain procedure was not to be run at the prevailing temperature, it was skipped and the next procedure in the sequence was run.

Federal Test Procedure--

The FTP was always run first. Regulated emissions were sampled by the CVS three-bag procedure. In addition to the normal analysis for HC, CO, CO_2, and NOX, samples from each of the three diluted exhaust bags were extracted for analyses using a gas chromatograph to measure individual hydrocarbons. During this FTP three-phase test, separate sample lines from the CVS-diluted-exhaust supplied the sample gas to the aldehyde and hydrogen sulfide impingers.

The 12-channel L&N temperature recorder was on for the entire daily testing sequence. When the sampler was activated for the start of the test, the Doric temperature recorder began recording the exhaust gas temperature and time intervals. If the vehicle had just one catalyst, only two (before and after) temperatures were recorded and the time intervals were one second. If four temperatures were recorded, the time interval was two seconds; and if six, intervals of four seconds were obtained. When the exhaust temperature out of the catalyst exceeded the exhaust temperature into the catalyst, this was called light-off time and the recorder was reset to record the remainder of the test at one-minute intervals. As soon as each phase of the FTP was completed, the sample and dilution air bags were analyzed. During the driving cycle the driver made comments on the vehicle driveability. These were recorded along with the idle rpm and vacuum readings obtained at the initial idle in "neutral" and the idle in "drive" after the first mode of the driving schedule. After completing the sampling period for the FTP, the driver let the engine idle in neutral while the driver's aid charts were changed and the sampling system prepared for the next test. Maximum elapsed time between procedures was three minutes.

Sulfate Emission Test--

The SET was run next if it was scheduled. If it was not scheduled, the next test (HFET) was run. To run the SET, the exhaust from the vehicle was directed into the dilution tunnel. At a command from the driver, the CVS sampler and the particulate and sulfate sampling system were activated. Two sample probes in the dilution tunnel provided two separate filter samples from this test. The filter flow rate was held constant to provide an isokinetic flow for the entire test. At the conclusion of the SET, the driver again let the engine idle in neutral while the driver's aid charts were changed and the sampling system prepared for the next procedure. The exhaust flow was changed to bypass the dilution tunnel and the CVS bags removed for normal analysis of HC, CO, CO_2, and NOX. The maximum time between procedures was three minutes.

Highway Fuel Economy Test--

At a command from the driver, the HFET sampling was begun. At the conclusion of this test, the driver stopped the engine for three minutes while the driver's aid charts were changed and the sampling system prepared for the next test. The CVS bags were analyzed in the same manner as for the FTP.

Federal Short Tests/New York City Cycle--

The FSC was run next for the first six test vehicles if it was scheduled. For the last eight vehicles tested, the NYCC could be on the schedule and would be conducted at this time. If either test was scheduled, the driver would start the engine after a three minute shutdown and idle in neutral for three minutes. The sampling period for either the FSC or NYCC would then begin. At the conclusion of the NYCC procedure, testing for the day was terminated. When the FSC was run, the driver would stop the engine for three minutes, disengage the dynamometer inertia weights, turn off the vehicle cooling air (wind tunnel) and preset the electrical dynamometer load for the F3M test. The FSC sample bags were analyzed in the same manner as they were for the SET and HFET.

Federal 3 Mode--

After three minutes downtime, the engine was started and idled in neutral for three minutes before starting the loaded cruise conditions for the F3M. For the remainder of the testing, raw exhaust only is analyzed. The sample was obtained through the stainless steel line inside the flex tubing attached to the vehicle tail pipe. The exhaust was analyzed for HC, CO, and NOX using the Beckman and Thermo-Electron instruments. Simultaneously, the raw exhaust was analyzed for HC and CO using the Stewart-Warner garage-type analyzer. The 80 km/h (50 mph) cruise was run first. When the emissions stabilized (approximately one minute) all readings were recorded and the 48 km/h (30 mph) mode was run. The idle mode was then run, first in neutral and then in drive with wheels braked on automatic transmission cars. If the engine water or catalyst temperatures exceeded safe limits, the dynamometer cooling air was used. The 2500 rpm unloaded test was then performed. Another set of readings at idle in neutral were obtained. This concluded the testing for the day.

Data Handling--

All of the temperature and humidity recording charts were removed, identified and placed in a packet labeled with the vehicle and test numbers. The Visicorder chart with the regulated emission analysis results from the instrument bench was manually converted to concentrations and these data entered on computer input sheets. The tread roll revolution counts from all of the cycles were converted to miles and the average temperatures necessary for flow corrections were also entered. Later, when all of the unregulated emission analysis information was received, the computer input sheets were completed, cards were punched and sent to the main computer for processing. Temperature plots of the catalyst "out" temperature versus time of the FTP were made. The plot starts when the catalyst "in" temperature reached 200°F (90°C) and continues at twelve-second intervals until light-off is reached, then continues at one minute intervals for the remainder of the test. The maximum and minimum temperatures of the other driving cycles were recorded but not plotted. The drivers charts with inked recordings of the actual cycle operation were checked for driving errors. If errors were determined, the day's testing was rescheduled for the following day, otherwise the test cell was set for the next scheduled temperature. All of the data were then placed in their packet and filed for future handling.

ANALYTICAL

Detailed procedures for component analysis and reporting methods are contained in the Federal Register and EPA Publications.

Regulated Emissions

CO, CO_2, HC, NOX (and NOXC) were sampled, analyzed, and calculated as required by the Federal Register (16). Calibration tests of the analytical and sampling instruments were also performed as required. The frequency of these calibrations was varied slightly so they would occur at the start of testing for each car.

The fuel economy results were calculated using the carbon balance method described in the Federal Register.(17)

Unregulated Emissions

Individual Hydrocarbons--

Gas chromatography was used to detect and measure C_1 through C_{12} hydrocarbon components. These gas samples were obtained from each of the three diluted exhaust bags collected during the FTP.

A Perkin-Elmer 900 chromatograph was modified for the rapid routine analysis of automotive exhausts and similar samples. The apparatus and operating procedure are modeled after the proposed Standard CRC-APRAC Chromatographic Method for Automobile Exhaust (18). However, other modifications were made whenever they seemed advantageous.

Exhaust analyses can be made over a concentration range of 50-2000 ppmc with a mimumum reproducible detection of about 1 ppmc per component. Liquid samples such as gasoline fuels and condensed fuel vapors can be blended in cylinders with nitrogen to 500-2000 ppmc and analyzed as a gaseous blend. The analysis of C_1 and C_2 hydrocarbons is performed on packed columns while an open tubular column is used for C_3 through C_{12} components.

Aldehydes--

The procedure for the measurement of carbonyl compounds in exhaust by the 2,4-Dinitrophenylhydrazine (DNPH) method was used for this program. A composite sample from the three phases of the FTP was analyzed by a modification of the procedure shown in reference (19).

Hydrogen Sulfide--

A gas chromatographic procedure was used for the first four vehicles tested. No H_2S was detected with this method of analyzing a diluted exhaust bag sample. It was later learned that NO_2 apparently reacts with H_2S. Thereafter, a procedure entitled "The Measurement of Hydrogen Sulfide in Exhaust," published by the Department of Emissions Research, Southwest Research Institute, was used (20). It is accomplished by passing the diluted exhaust through glass impingers containing a cadmium hydroxide solution. A composite sample from the three phases of the FTP was taken. The absorbing solution is treated with N, N dimethyl-paraphenylene diamine sulfate and ferric ammonium sulfate. The highly colored methylene blue compound is formed and analyzed with a colorimeter.

Sulfate and Particulates--

Within one hour of the sulfate test, the filters are removed from the collection system and placed in an open petri dish. This dish is then placed in a desiccator and exposed to concentrated ammonium hydroxide (NH_4OH) vapors for at least 30 minutes. The sulfuric acid (H_2SO_4) is thus converted to ammonium sulfate and water. The water quickly evaporates from the filters and their weight is stabilized within two days when conditioned in the temperature and humidity-controlled weighing room. The tare weight of the filter had been established prior to the test and the weight gain was attributed to particulates and ammonium sulfate. These filters were then processed and analyzed by using the barium chloranilate system to obtain the sulfate equivalent mass on the filters which is then corrected for the ammonia added. Two probes and filters were used and, thus, two sets of results were obtained to check the reliability of the system. The data were extremely close, so the average only was reported.

Section 5

RESULTS AND DISCUSSIONS

The individual test results are tabulated in Appendices A, B, and C. Appendix A contains individual test results on catalyst temperatures, driveability, and emissions for each test procedure. Appendix B contains graphs of the exhaust gas temperatures leaving the catalyst plotted versus time from initial start. An indication of whether these temperatures were higher than those entering the catalyst is also given. Appendix C contains all of the component chromatographic data obtained using the 1975 Federal Test Procedure (FTP).

The discussions which follow are based on the results shown in the summary tables and figures included in the text. In the figures, the average emissions for each car on each test cycle are plotted against ambient test temperatures. In the tables, periods represent test conditions that were not run, either because there was no air conditioner or because a triplicate test was run at one or more temperatures and not at the remaining temperatures.

The 49 State and California emission standards that these test cars were designed to meet at temperatures from 68°F (20°C) to 86°F (30°C) are shown in Table 15.

TABLE 15. 49 STATE AND CALIFORNIA EMISSION STANDARDS, g/km

	49 State			California		
	HC	CO	NOX	HC	CO	NOX
1972*	1.88	17.5	--	1.77	17.5	1.93
1974*	1.88	17.5	1.93	1.77	17.5	1.27
1977	0.93	9.3	1.24	0.25	5.6	0.93
1978	0.93	9.3	1.24	0.25	5.6	0.93
1979	0.93	9.3	1.24	0.25	5.6	0.93
1980	0.25	4.35	1.24	0.25	5.7	0.62

* Calculated on the EPA approved equivalency basis for the 1975 Federal Test Procedure.

EMISSIONS

Hydrocarbons (HC)

Figure 4 shows the average hydrocarbon emission results for each of the three phases of the Federal Test Procedure (FTP) by car. Figure 5 shows the average emissions for the Composite FTP, the Highway Fuel Economy Test, the Sulfate Emission Test and either the Federal Short Cycle or the New York City Cycle, depending on which of the two tests was run. All tests run without the vehicle air conditioner being used are connected by a line through their corresponding symbols. Results from the tests where the air-conditioners were used cars have corresponding symbols plotted, but do not have connecting lines.

Federal Test Procedure - Cold Transient Phase - HC--

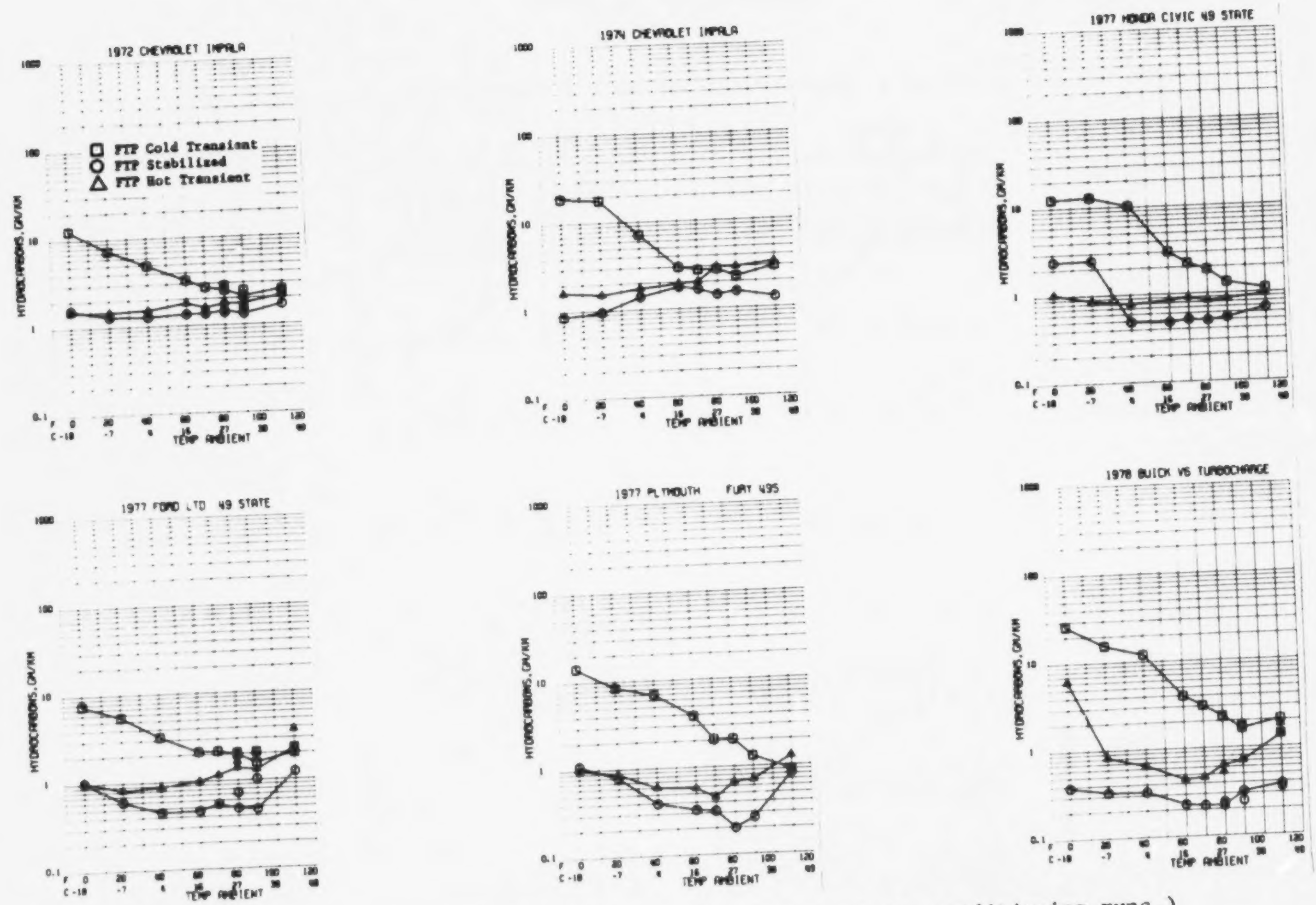
Table 16 summarizes the hydrocarbon emission data in grams per kilometer (g/km) for the cold transient phase (C-TR) of the Federal Test Procedure. This condition, where the car was soaked at least 12 hours and normally 24 hours, showed the greater variability in emissions and in repeatability. If stalls or hesitations, occurred, hydrocarbons increased.

The first three cars listed in Table 16 were noncatalyst cars. Their HC emissions were the highest at 0°F (-18°C).or 20°F (-7°C). This was true of all of the cars tested. The minimum hydrocarbons occurred at 90°F (32°C) for the 1972 and 1974 Chevrolets and 110°F (43°C) for the Honda. The use of air conditioning in the 1972 Chevrolet increased its hydrocarbon emissions at 80 and 90°F (27 and 32°C) but not at 110°F (43°C).

The next three cars (the 1977 Ford, the 1977 Plymouth, and the 1978 Buick-turbocharged) were all certified to meet current 49 State emission standards. The 1978 Buick had exceptionally high hydrocarbon emissions at 0, 20, and 40°F (-18, -7, and 4°C). The (49 State) Plymouth was high in hydrocarbon emissions at 0°F (-18°C) but decreased to a very low value at 110°F (43°C). The use of air conditioning generally produced more hydrocarbons with the Ford, but less with the Buick. The Plymouth had no air conditioning.

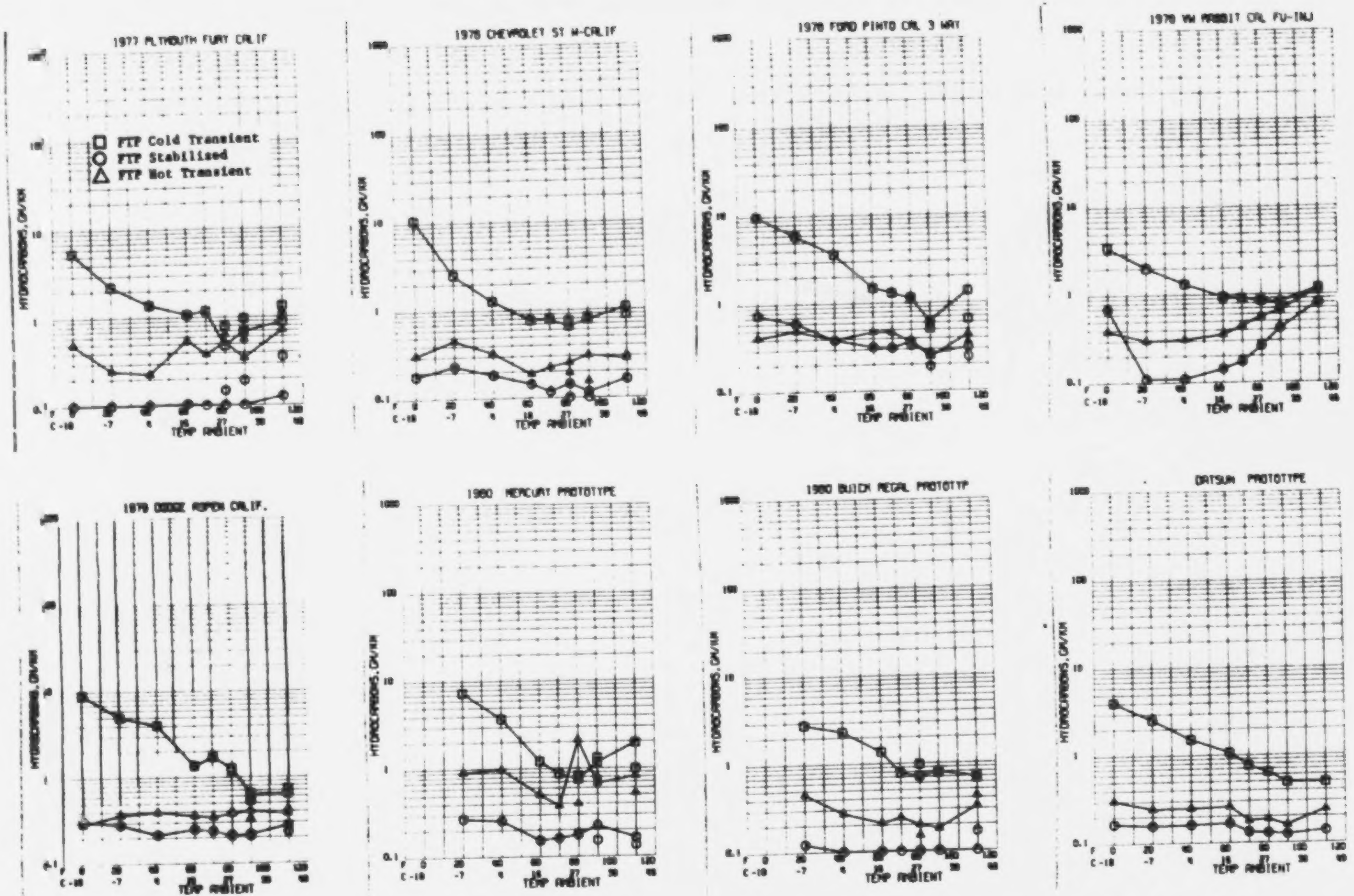
The next five cars (the 1977 Plymouth, the 1978 Chevrolet, the 1978 Ford, the 1978 VW, and the 1979 Dodge) were all certified to meet California emission standards. These five cars generally had lower hydrocarbon emissions at all temperatures than the three preceding 49-state cars. The Chevrolet, the Ford, and the Dodge produced high hydrocarbon emissions at 0°F (-18°C). The VW, at 0°F (-18°C), had the lowest hydrocarbon emissions of all the cars tested. Its emissions increased some at 110°F (43°C) from its low which occurred between 60 and 90°F (16 and 32°C).

The last three cars (the Mercury, the Buick and the Datsun) were all prototype cars designed to meet 1980 or later emission standards.



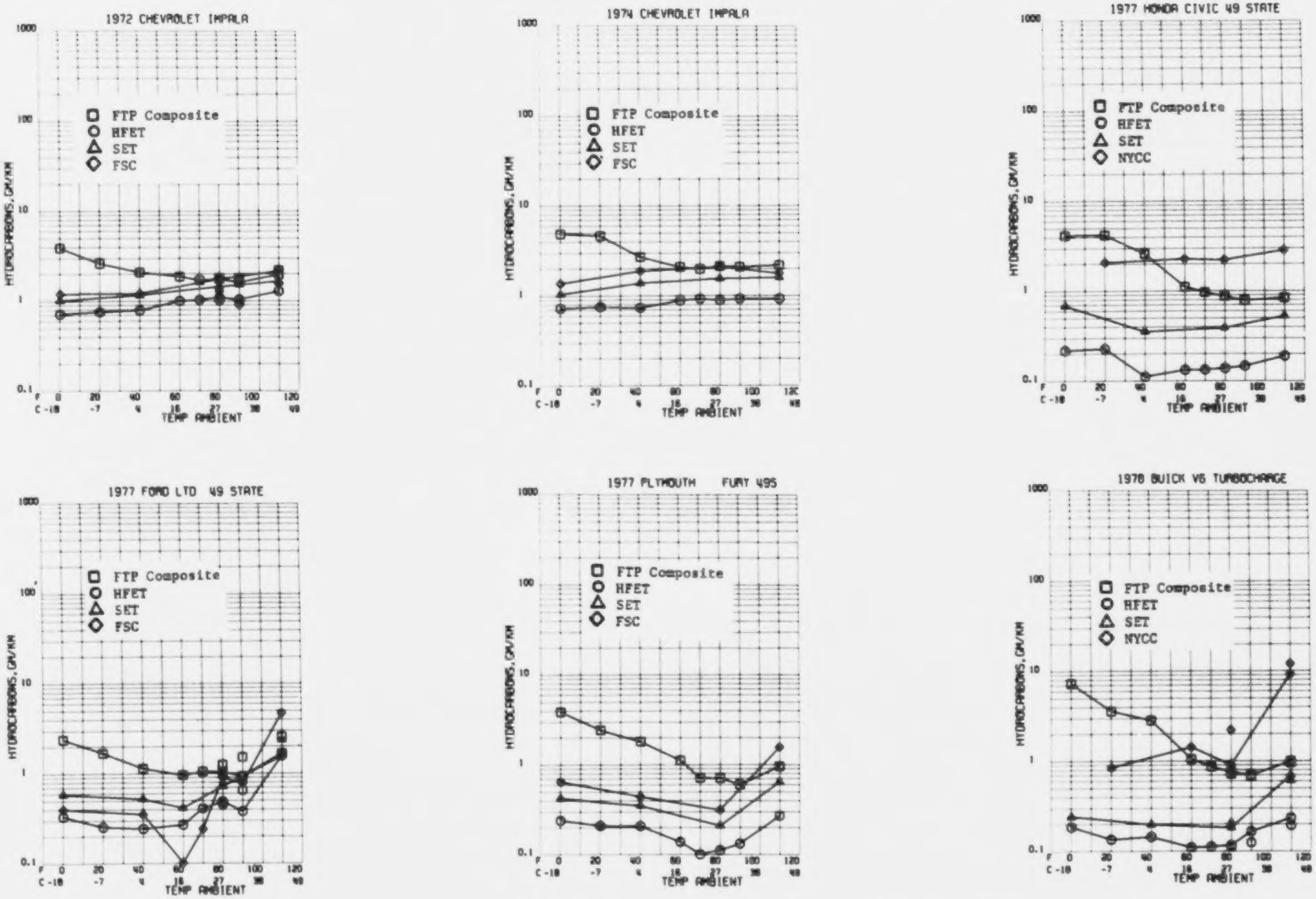
(Data points not connected by a line are the results of air conditioning runs.)

Figure 4. Effect of ambient temperature on hydrocarbon emissions for the three phases of the FTP.



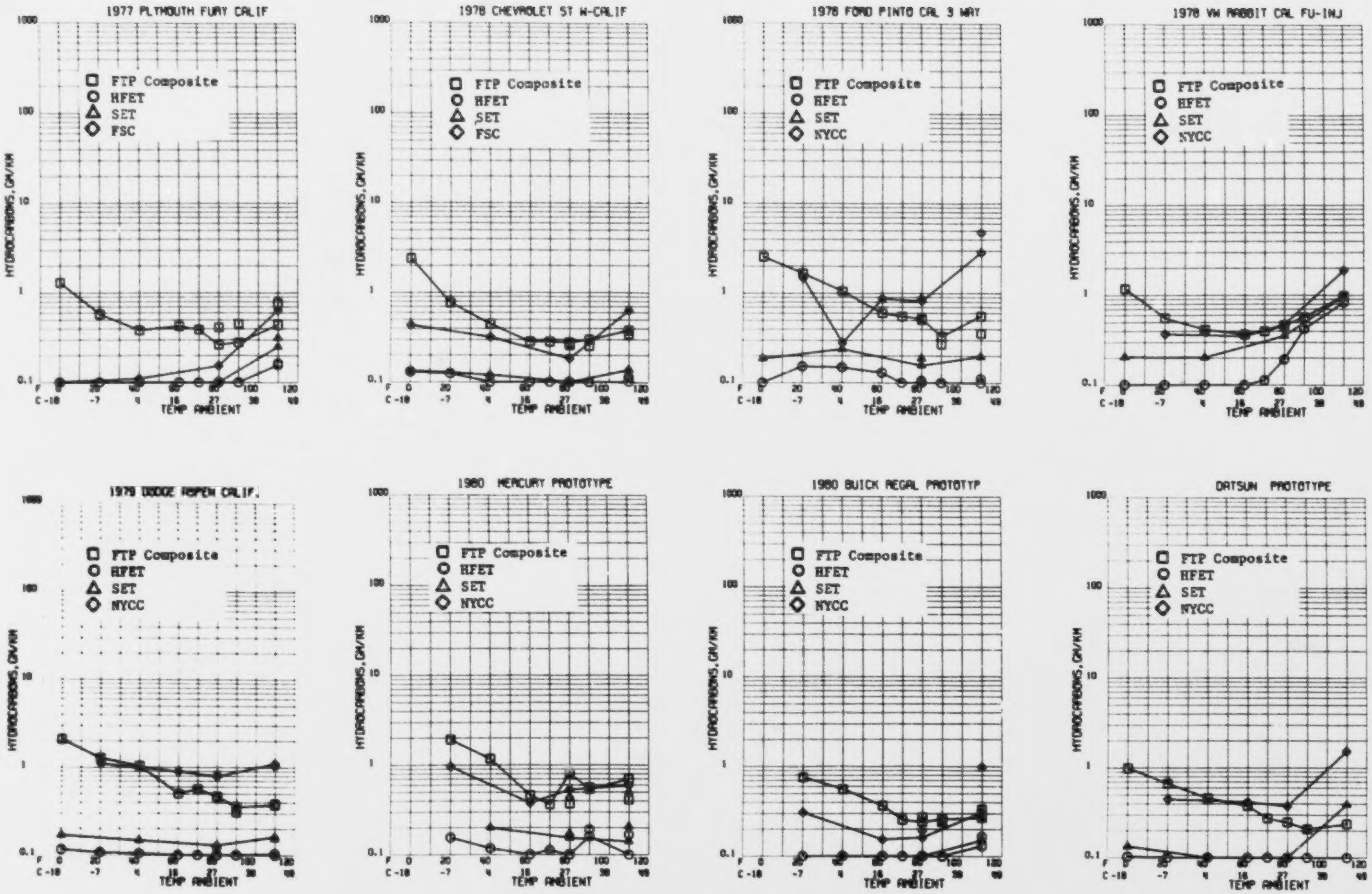
(Data points not connected by a line are the results of air conditioning runs.)

Figure 4. (continued)



(Data points not connected by a line are the results of air conditioning runs.)

Figure 5. Effect of ambient temperature on hydrocarbon emissions for different test cycles.



(Data points not connected by a line are the results of air conditioning runs.)

Figure 5. (continued)

The Mercury and the Buick were not tested at 0°F (-18°C) and only single tests were conducted at five of the test conditions. This was done to expedite the return of the cars. Hydrocarbon emissions from all three cars were generally low, but all showed some increase in emissions at the lower temperatures.

TABLE 16   F T P COLD TRANSIENT   - HYDROCARBONS G/KM

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	12.89 12.41	7.27 7.31	4.51 5.28	2.90 3.59	2.44 2.89	2.19 2.74	2.53 3.01	1.97 2.20	2.46 2.35	2.39 2.53	2.10 2.34
AVE	12.65	7.29	4.90	3.25	2.67	2.47	2.77	2.09	2.41	2.46	2.22
1976 CHEVROLET IMPALA	19.88 18.41 .	22.90 13.08 .	3.42 10.91 .	3.11 2.56 3.25	2.92 2.52 .	3.15 2.34 .	. . .	2.38 2.17 .	. . .	3.05 2.74 .	. . .
AVE	19.14	17.99	7.17	2.97	2.72	2.75	.	2.27	.	2.90	.
1977 HONDA CIVIC 49 STATE	11.89 13.08	17.00 9.00	3.49 17.09	2.89 3.14	2.26 2.18	1.70 2.02	. .	1.32 1.31	. .	1.11 1.12	. .
AVE	12.49	13.00	10.29	3.02	2.22	1.86	.	1.31	.	1.11	.
1977 FORD LTD 49 STATE	7.56 8.29 6.89	6.45 4.62 .	3.28 3.15 .	1.90 2.36 .	2.06 2.23 .	1.95 1.97 .	2.05 2.06 .	1.61 1.53 .	2.18 1.97 .	2.13 1.84 .	2.08 2.47 .
AVE	7.58	5.53	3.22	2.13	2.15	1.96	2.06	1.57	2.08	1.98	2.28
1977 PLYMOUTH FURY 49S	14.94 13.63 .	6.79 10.11 .	2.76 10.91 .	. 6.01 3.23	0.70 3.64 1.81	2.30 1.77 .	. . .	1.14 1.45 .	. . .	0.85 0.92 .	. . .
AVE	14.28	8.45	6.83	4.62	2.05	2.03	.	1.29	.	0.89	.
1978 BUICK V6 TURBOCHARGE	. 22.47 24.80	16.69 14.29 .	7.84 16.27 .	4.14 3.76 .	3.32 2.72 .	2.43 2.12 .	2.30 2.08 .	1.52 1.74 .	1.47 1.98 .	1.21 2.89 .	1.45 1.31 .
AVE	23.64	15.49	12.05	3.95	3.02	2.28	2.19	1.63	1.73	2.05	1.38
1977 PLYMOUTH FURY CALIF	4.83 5.85 .	2.14 2.32 .	1.21 1.53 .	0.94 1.20 .	0.67 1.65 .	0.49 0.45 .	0.78 0.79 .	0.63 0.73 .	0.73 1.18 .	0.57 1.16 .	0.99 1.14 1.84
AVE	5.34	2.23	1.37	1.07	1.16	0.47	0.79	0.73	0.96	0.86	1.32
1976 CHEVROLET SW-CALIF	16.06 5.25	2.52 2.49	1.21 1.31	0.88 0.63	0.76 0.79	0.61 0.66	0.72 0.79	0.74 0.73	0.84 0.80	1.35 0.77	0.93 0.80
AVE	10.65	2.51	1.26	0.76	0.78	0.64	0.75	0.76	0.82	1.06	0.86
1978 FORD PINTO CAL 3 WAY	8.36 9.02 12.01	4.64 7.06 .	3.24 3.95 .	1.15 1.82 .	1.43 1.16 .	1.66 0.57 .	1.35 0.92 .	0.77 0.65 0.42	0.50 0.51 .	1.94 0.76 .	0.54 0.60 0.80
AVE	9.60	5.85	3.60	1.46	1.29	1.11	1.14	0.62	0.50	1.35	0.65
1976 VW RABBIT CAL FU-INJ	3.56 3.34	2.08 1.95	1.31 1.33	0.82 1.06	0.88 0.91	0.78 0.90	. .	0.72 0.91	. .	1.09 1.26	. .
AVE	3.45	2.01	1.32	0.94	0.90	0.84	.	0.82	.	1.17	.
1979 DODGE ASPEN CALIF.	10.57 7.43	7.02 2.88	3.39 4.60	1.11 1.58	0.64 2.76	0.50 2.01	0.64 1.64	0.55 0.73	0.41 0.65	0.60 0.66	0.71 0.74
AVE	9.00	4.95	4.00	1.34	1.70	1.26	1.14	0.64	0.53	0.63	0.72
1980 MERCURY PROTOTYPE	. .	6.99 7.61	3.68 .	1.19 .	0.70 1.02	0.77 0.72	0.82 .	1.16 .	1.31 .	2.12 1.72	0.93 1.04
AVE	.	7.30	3.68	1.19	0.86	0.74	0.82	1.16	1.31	1.92	0.98
1980 BUICK REGAL PROTOTYP	. .	2.96 2.58	2.30 .	1.34 .	0.79 0.74	0.73 0.68	0.97 .	0.79 .	0.77 .	0.79 0.58	0.74 0.57
AVE	.	2.77	2.30	1.34	0.77	0.71	0.97	0.79	0.77	0.69	0.66
DATSUN PROTOTYPE	4.30 3.72 .	2.32 2.74 .	1.59 . 1.40	1.19 0.95 .	0.72 0.78 .	0.59 0.67 .	. . .	0.48 0.48 .	. . .	0.50 0.46 .	. . .
AVE	4.01	2.53	1.49	1.07	0.75	0.63	.	0.48	.	0.48	.

Federal Test Procedure - Stabilized Phase - HC--

Table 17 summarizes the results of the hydrocarbon emissions for the stabilized phase (STAB) of the FTP. This phase, which continues without shutdown from the cold transient phase, generally produced the lowest emissions of the three phases. The cars, after 8.4 minutes driving in the cold transient phase were warmed up substantially. This is demonstrated by the low hydrocarbon emissions at 0 and 20°F (-18 and -7°C) relative to corresponding temperatures of the proceeding cold transient phase. Driveability problems were generally not encountered during this phase.

TABLE 17 F T P STABILIZED - HYDROCARBONS G/KM

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	1.63	1.28	1.12	1.32	1.36	1.38	1.40	1.18	1.51	1.49	1.95
	1.53	1.32	1.44	1.36	1.32	1.50	1.35	1.46	1.45	1.83	2.36
AVE	1.58	1.30	1.28	1.34	1.34	1.44	1.38	1.32	1.48	1.66	2.16
1974 CHEVROLET IMPALA	0.93	0.98	1.38	1.23	1.23	1.43	.	1.65	.	1.22	.
	0.81	0.94	1.41	1.65	2.06	1.41	.	1.43	.	1.40	.
	.	.	.	2.46	.	.	.	.	.	.	.
AVE	0.87	0.96	1.40	1.78	1.64	1.42	.	1.54	.	1.31	.
1977 HONDA CIVIC 49 STATE	2.32	2.66	0.43	0.44	0.50	0.50	.	0.53	.	0.71	.
	2.55	2.27	0.53	0.52	0.51	0.48	.	0.52	.	0.63	.
AVE	2.44	2.46	0.48	0.48	0.51	0.49	.	0.52	.	0.67	.
1977 FORD LTD 49 STATE	1.01	0.54	0.38	0.47	0.49	0.48	0.67	0.50	1.21	1.38	2.07
	1.07	0.65	0.52	0.44	0.60	0.48	0.77	0.42	0.84	1.06	2.11
	0.98	.	.	.	.	.	.	.	.	.	.
AVE	1.02	0.60	0.45	0.46	0.54	0.48	0.72	0.46	1.02	1.22	2.09
1977 PLYMOUTH FURY 495	1.38	0.58	0.22	0.28	0.06	0.23	.	0.22	.	0.95	.
	0.82	1.01	0.56	0.39	0.66	0.17	.	0.29	.	0.67	.
	.	.	.	0.31	0.21	.	.	.	.	.	.
AVE	1.10	0.79	0.39	0.33	0.31	0.20	.	0.26	.	0.81	.
1978 BUICK V6 TURBOCHARGE	0.38	0.36	0.36	0.21	0.20	0.20	0.21	0.23	0.25	0.43	0.37
	0.36	0.30	0.28	0.25	0.24	0.23	0.27	0.40	0.24	0.32	0.33
	0.40	.	.	.	.	.	.	.	.	.	.
AVE	0.38	0.33	0.32	0.23	0.22	0.22	0.24	0.31	0.24	0.37	0.35
1977 PLYMOUTH FURY CALIF	0.12	0.08	0.06	0.07	0.03	0.04	0.13	0.09	0.23	0.10	0.21
	0.07	0.08	0.07	0.14	0.14	0.05	0.16	0.10	0.15	0.15	0.51
	.	.	.	.	.	.	.	.	.	.	0.35
AVE	0.09	0.08	0.07	0.10	0.08	0.05	0.15	0.10	0.19	0.13	0.36
1978 CHEVROLET ST W-CALIF	0.13	0.18	0.19	0.08	0.12	0.11	0.08	0.10	0.10	0.18	0.17
	0.22	0.28	0.18	0.20	0.11	0.18	0.11	0.13	0.06	0.15	0.15
AVE	0.18	0.23	0.18	0.14	0.12	0.14	0.10	0.12	0.08	0.16	0.16
1978 FORD PINTO CAL 3 WAY	0.36	0.53	0.24	0.27	0.31	0.41	0.38	0.37	0.20	0.22	0.19
	1.01	0.66	0.53	0.36	0.30	0.31	0.27	0.23	0.17	0.39	0.19
	0.88	.	.	.	.	.	.	0.18	.	.	0.34
AVE	0.75	0.60	0.38	0.32	0.31	0.36	0.33	0.26	0.19	0.31	0.24
1978 VW RABBIT CAL FU-INJ	0.33	0.13	0.13	0.14	0.16	0.25	.	0.31	.	0.79	.
	1.04	0.09	0.09	0.15	0.19	0.27	.	0.52	.	0.83	.
AVE	0.69	0.11	0.11	0.14	0.17	0.26	.	0.41	.	0.81	.
1979 DODGE ASPEN CALIF.	0.50	0.35	0.24	0.25	0.23	0.19	0.22	0.22	0.20	0.29	0.24
	0.12	0.21	0.19	0.24	0.24	0.22	0.21	0.21	0.22	0.25	0.22
AVE	0.31	0.28	0.21	0.25	0.24	0.21	0.21	0.22	0.21	0.27	0.23
1980 MERCURY PROTOTYPE	.	0.29	0.25	0.15	0.17	0.14	0.18	0.22	0.15	0.15	0.15
	.	0.25	.	.	0.15	0.21	.	.	.	0.17	0.11
AVE	.	0.27	0.25	0.15	0.16	0.17	0.18	0.22	0.15	0.16	0.13
1980 BUICK REGAL PROTOTYP	.	0.15	0.01	0.06	0.06	0.08	0.06	0.09	0.06	0.09	0.17
	.	0.10	.	.	0.06	0.07	.	.	.	0.07	0.16
AVE	.	0.12	0.01	0.06	0.06	0.07	0.06	0.09	0.06	0.08	0.16
DATSUN PROTOTYPE	0.15	0.14	0.17	0.18	0.14	0.13	.	0.12	.	0.14	.
	0.18	0.17	0.15	0.16	0.13	0.13	.	0.13	.	0.13	.
	.	.	0.16	.	.	.	.	.	.	.	.
AVE	0.17	0.16	0.16	0.17	0.13	0.13	.	0.13	.	0.14	.

The stabilized phase data demonstrate that the emissions were reduced as the vehicles were designed to meet the more stringent standards. This was generally true at all temperatures.

The effect of the air conditioners (AC) in operation can still be observed in this phase. The 1972 Chevrolet, the 1977 Ford, and the 1977 (California) Plymouth all had higher hydrocarbon emissions with their AC on. However, the 1978 California Pinto had reduced hydrocarbon emissions with its AC on. The remaining AC cars showed little effect from the use of their AC.

Federal Test Procedure - Hot Transient Phase - HC--

Table 18 shows the average hydrocarbon emissions for the hot transient phase (H-TR) of the FTP. This phase includes a start after a ten-minute soak following the stabilized phase. Therefore, hydrocarbon emissions in this phase were more than those in the stabilized phase. Driveability problems did not usually occur during this phase. The effect of reduced temperature was not pronounced in this phase unless there was a starting or driveability problem, such as occurred with the 1978 Buick at 0°F (-18°C). Again, use of the air conditioners gave mixed results. With a few cars, their use gave higher hydrocarbon emissions while with the remaining ones they either had no effect or gave less hydrocarbon emissions.

TABLE 18 F T P HOT TRANSIENT - HYDROCARBONS G/KM

TEMPERATURE F	0	20	40	60	70	80	80AC	90	90AC	110	110AC
(C)	(-18)	(-7)	(4)	(16)	(21)	(27)	(27)	(32)	(32)	(43)	(43)
1972 CHEVROLET IMPALA	1.64	1.54	1.70	1.88	1.54	1.59	2.04	1.93	1.83	1.86	2.11
	1.35	1.39	1.35	1.69	1.62	1.89	1.61	1.55	1.58	2.36	2.19
AVE	1.49	1.47	1.52	1.78	1.58	1.74	1.82	1.74	1.70	2.11	2.15
1974 CHEVROLET IMPALA	1.64	1.35	1.95	1.88	2.05	2.98	.	2.92	.	3.51	.
	1.62	1.69	1.54	2.01	1.97	2.88	.	2.95	.	2.99	.
	.	.	.	1.90	.	.	.	.	.	.	.
AVE	1.63	1.52	1.74	1.93	2.01	2.93	.	2.94	.	3.25	.
1977 HONDA CIVIC 49 STATE	1.03	0.93	0.74	0.74	1.00	0.88	.	0.91	.	0.94	.
	1.05	0.80	0.83	0.95	0.80	0.77	.	0.80	.	0.96	.
AVE	1.04	0.86	0.79	0.85	0.90	0.83	.	0.86	.	0.95	.
1977 FORD LTD 49 STATE	0.88	0.73	0.89	1.04	1.23	1.44	1.43	1.29	2.20	2.25	4.15
	1.01	0.92	0.85	0.96	1.09	1.35	1.82	1.31	1.77	2.28	3.17
	1.19	.	.	.	.	.	.	.	.	.	.
AVE	1.03	0.82	0.87	1.00	1.16	1.39	1.63	1.30	1.99	2.27	3.66
1977 PLYMOUTH FURY 49S	1.23	0.78	0.46	0.58	0.21	0.76	.	0.72	.	1.27	.
	0.77	0.98	0.74	0.53	0.62	0.56	.	0.66	.	1.28	.
	.	.	.	0.61	0.51	.	.	.	.	.	.
AVE	1.00	0.88	0.60	0.57	0.45	0.66	.	0.70	.	1.27	.
1978 BUICK V6 TURBOCHARGE	1.45	1.04	0.58	0.38	0.40	0.41	0.51	0.64	0.70	1.86	2.39
	0.95	0.61	0.72	0.51	0.52	0.84	0.55	0.75	0.73	0.86	1.17
	0.31	.	.	.	.	.	.	.	.	.	.
AVE	0.24	0.82	0.65	0.44	0.46	0.63	0.53	0.70	0.72	1.36	1.78
1977 PLYMOUTH FURY CALIF	0.52	0.27	0.25	0.67	0.39	0.52	0.68	0.31	0.66	0.83	0.91
	0.47	0.23	0.21	0.42	0.37	0.50	0.58	0.37	0.46	0.59	1.30
	.	.	.	.	.	.	.	.	.	.	1.19
AVE	0.49	0.25	0.23	0.55	0.38	0.51	0.63	0.37	0.56	0.71	1.14
1978 CHEVROLET ST W-CALIF	0.28	0.36	0.32	0.18	0.22	0.23	0.20	0.29	0.18	0.24	0.24
	0.34	0.55	0.33	0.20	0.22	0.27	0.18	0.32	0.12	0.31	0.36
AVE	0.31	0.46	0.33	0.19	0.22	0.25	0.19	0.30	0.15	0.27	0.30
1978 FORD PINTO CAL 3 WAY	0.41	0.45	0.10	0.35	0.41	0.45	0.43	0.31	0.22	0.39	0.34
	0.44	0.54	0.48	0.58	0.51	0.26	0.28	0.24	0.27	0.48	0.27
	0.40	.	.	.	.	.	.	0.17	.	.	0.45
AVE	0.42	0.49	0.39	0.47	0.46	0.36	0.36	0.24	0.25	0.43	0.35
1978 VW RABBIT CAL FU-INJ	0.35	0.30	0.11	0.10	0.44	0.58	.	0.60	.	1.13	.
	0.43	0.30	0.11	0.41	0.45	0.54	.	0.73	.	1.19	.
AVE	0.39	0.30	0.11	0.35	0.44	0.56	.	0.67	.	1.16	.
1979 DODGE ASPEN CALIF.	0.28	0.33	0.33	0.26	0.34	0.37	0.38	0.41	0.24	0.40	0.42
	0.29	0.39	0.45	0.45	0.35	0.37	0.40	0.39	0.41	0.34	0.41
AVE	0.29	0.36	0.39	0.36	0.34	0.37	0.39	0.40	0.32	0.37	0.42
1980 MERCURY PROTOTYPE	.	0.95	0.98	0.50	0.48	3.49	0.39	0.67	0.78	1.16	0.63
	.	0.88	.	.	0.26	0.69	.	.	.	0.45	0.40
AVE	.	0.91	0.98	0.50	0.37	2.09	0.39	0.67	0.78	0.80	0.52
1980 BUICK REGAL PROTOTYP	.	0.36	0.27	0.21	0.22	0.19	0.15	0.18	0.18	0.37	0.36
	.	0.54	.	.	0.26	0.20	.	.	.	0.26	0.47
AVE	.	0.45	0.27	0.21	0.24	0.20	0.15	0.18	0.18	0.32	0.42
DATSUN PROTOTYPE	0.28	0.21	0.23	0.29	0.19	0.17	.	0.16	.	0.28	.
	0.33	0.28	0.24	0.23	0.17	0.19	.	0.16	.	0.20	.
	.	.	0.26	.	.	.	.	.	.	.	.
AVE	0.30	0.24	0.25	0.26	0.18	0.18	.	0.16	.	0.24	.

Federal Test Procedure - Composite Samples - HC--

Data on Hydrocarbon Emissions for composite samples of the FTP are presented in Table 19. These values indicate whether or not a vehicle is within certification limits. The emission standards are listed in Table 15. Most of the cars met the hydrocarbon emission standards at temperatures of 70 and 80°F (21 and 27°C).

TABLE 19 F T P COMPOSITE - HYDROCARBONS G/KM

TEMPERATURE F	0	20	40	60	70	80	80AC	90	90AC	110	110AC
(C)	(-18)	(-7)	(4)	(16)	(21)	(27)	(27)	(32)	(32)	(43)	(43)
1972 CHEVROLET IMPALA	3.96	2.58	1.98	1.79	1.63	1.60	1.80	1.55	1.79	1.77	2.02
	3.75	2.59	2.17	1.91	1.72	1.86	1.76	1.64	1.67	2.12	2.31
AVE	3.85	2.58	2.07	1.85	1.68	1.73	1.78	1.59	1.73	1.95	2.17
1974 CHEVROLET IMPALA	5.04	5.58	1.96	1.79	1.80	2.21	.	2.15	.	2.22	.
	4.65	3.62	3.40	1.93	2.13	2.00	.	2.00	.	2.11	.
	.	.	.	2.47	.	.	.	.	.	.	.
AVE	4.85	4.60	2.68	2.07	1.96	2.11	.	2.07	.	2.16	.
1977 HONDA CIVIC 49 STATE	3.93	5.09	1.15	1.02	1.00	0.85	.	0.79	.	0.85	.
	4.10	3.24	3.98	1.17	0.93	0.88	.	0.76	.	0.82	.
AVE	4.11	4.17	2.57	1.10	0.96	0.86	.	0.78	.	0.84	.
1977 FORD LTD 49 STATE	2.32	1.81	1.12	0.92	1.01	1.04	1.16	0.95	1.68	1.76	2.63
	2.53	1.54	1.15	0.98	1.06	1.02	1.32	0.89	1.32	1.56	2.47
	2.27	.	.	.	.	.	.	.	.	.	.
AVE	2.37	1.68	1.13	0.95	1.04	1.03	1.24	0.92	1.50	1.66	2.55
1977 PLYMOUTH FURY 49S	4.16	1.92	0.82	0.76	0.24	0.80	.	0.55	.	1.01	.
	3.47	2.89	2.76	1.59	1.27	0.61	.	0.64	.	0.89	.
	.	.	.	0.99	0.62	.	.	.	.	.	.
AVE	3.82	2.41	1.79	1.11	0.71	0.70	.	0.59	.	0.95	.
1978 BUICK V6 TURBOCHARGE	6.92	3.89	1.98	1.06	0.89	0.71	0.72	0.60	0.62	0.98	1.14
	7.21	3.24	3.66	1.03	0.83	0.79	0.71	0.77	0.73	1.00	0.76
	7.56	.	.	.	.	.	.	.	.	.	.
AVE	7.23	3.57	2.82	1.05	0.86	0.75	0.72	0.69	0.68	0.99	0.95
1977 PLYMOUTH FURY CALIF	1.21	0.56	0.35	0.41	0.26	0.26	0.41	0.25	0.45	0.39	0.56
	1.37	0.59	0.41	0.43	0.51	0.26	0.40	0.30	0.44	0.48	0.85
	.	.	.	.	.	.	.	.	.	.	0.89
AVE	1.29	0.58	0.38	0.42	0.39	0.26	0.41	0.30	0.45	0.44	0.77
1978 CHEVROLET ST W-CALIF	3.47	0.71	0.43	0.27	0.28	0.25	0.25	0.29	0.28	0.44	0.35
	1.28	0.81	0.45	0.29	0.28	0.30	0.27	0.31	0.23	0.32	0.34
AVE	2.38	0.76	0.44	0.28	0.28	0.28	0.26	0.30	0.25	0.38	0.34
1976 FORD PINTO CAL 3 WAY	2.02	1.36	0.87	0.47	0.57	0.67	0.59	0.44	0.27	0.62	0.30
	2.50	1.94	1.22	0.72	0.53	0.36	0.41	0.32	0.27	0.49	0.29
	3.05	.	.	.	.	.	.	0.22	.	.	0.46
AVE	2.52	1.65	1.04	0.59	0.55	0.52	0.50	0.33	0.27	0.55	0.35
1976 VW RABBIT CAL FU-INJ	1.00	0.57	0.42	0.32	0.38	0.45	.	0.48	.	0.94	.
	1.35	0.53	0.40	0.40	0.41	0.47	.	0.66	.	1.01	.
AVE	1.17	0.55	0.41	0.36	0.39	0.46	.	0.57	.	0.98	.
1979 DODGE ASPEN CALIF.	2.39	1.73	0.91	0.43	0.34	0.30	0.35	0.34	0.25	0.38	0.38
	1.77	0.81	1.16	0.57	0.78	0.63	0.55	0.36	0.36	0.36	0.38
AVE	2.08	1.27	1.04	0.50	0.56	0.47	0.45	0.35	0.30	0.37	0.38
1980 MERCURY PROTOTYPE	.	1.86	1.16	0.46	0.36	1.17	0.37	0.53	0.56	0.82	0.44
	.	1.94	.	.	0.36	0.44	.	.	.	0.56	0.38
AVE	.	1.90	1.16	0.46	0.36	0.81	0.37	0.53	0.56	0.69	0.41
1980 BUICK REGAL PROTOTYP	.	0.78	0.55	0.36	0.25	0.24	0.27	0.26	0.24	0.31	0.34
	.	0.72	.	.	0.25	0.23	.	.	.	0.23	0.32
AVE	.	0.75	0.55	0.36	0.25	0.24	0.27	0.26	0.24	0.27	0.33
DATSUN PROTOTYPE	1.03	0.61	0.48	0.41	0.27	0.23	.	0.21	.	0.25	.
	0.94	0.72	0.45	0.34	0.27	0.26	.	0.21	.	0.22	.
	.	.	0.44	.	.	.	.	.	.	.	.
AVE	0.98	0.66	0.46	0.37	0.27	0.25	.	0.21	.	0.24	.

Again, the hydrocarbon emissions for all cars were the highest at 0°F (-18°C) and were frequently quite high at 20°F (-7°C). The effect of air conditioning was varied. Some cars, such as the 1972 Chevrolet, the 1977 Ford, and the 1977 (California) Plymouth had increased hydrocarbon emissions with AC on, while the other cars emissions were either variable or showed little effect.

Highway Fuel Economy Test- HC--

While hydrocarbon emissions are not required to meet an emission standard for any test other than the FTP, their level is of interest. The Highway Fuel Economy Test (HFET) was run either following the FTP or the Sulfate Emission Test (SET) after a three-minute maximum engine idle period. Because the SET test was run only at 0, 40, 80, and 110°F (-18, 4, 27, and 43°C) the cars running the HFET would be even more stabilized at these temperatures since the HFET was always run following the SET procedure. This effect is shown in Table 20 where the hydrocarbon emissions at 0°F (-18°C) are close to those at 20°F (-7°C). Hydrocarbon emission increases occurred at higher temperature in some of the vehicles while others showed little change.

It was noted that test repeatability was much better in warmed up engines than in cold engines. Even so, there were still substantial deviations. While the California version cars and prototype car gave the lowest hydrocarbon emissions, the 49 State cars were close behind. The 1977 Honda without a catalyst was also close to the hydrocarbon emission levels of the California cars.

Sulfate Emission Test - HC--

The Sulfate Emission Test (SET) was run immediately after the FTP following a maximum three-minute engine idle. This moderately high-speed continuous operation test gave hydrocarbon emissions that were generally low as is shown in Table 21.

As expected, the 1972 and 1974 Chevrolets, without catalysts, had the highest emissions. The 1977 Ford also had surprisingly high emissions. Except in the 1977 Ford, the use of air conditioning had only a small effect on hydrocarbon emissions.

TABLE 20 HIGHWAY FUEL ECONOMY TEST - HYDROCARBONS G/KM

TEMPERATURE F (C)	0 (-16)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	0.69	0.76	0.77	1.05	1.19	1.24	1.25	1.17	1.13	1.36	1.43
	0.74	0.74	0.79	0.94	0.86	0.93	0.76	0.88	0.73	1.16	1.11
AVE	0.71	0.75	0.78	0.99	1.02	1.08	1.01	1.03	0.93	1.27	1.27
1974 CHEVROLET IMPALA	0.73	0.69	0.80	0.89	0.83	0.86	.	0.99	.	1.00	.
	0.71	0.80	0.66	0.89	1.01	0.91	.	0.85	.	0.84	.
	.	.	.	0.87	.	.	.	.	.	.	.
AVE	0.72	0.75	0.73	0.88	0.92	0.88	.	0.92	.	0.92	.
1977 HONDA CIVIC 49 STATE	0.18	0.30	0.10	0.14	0.14	0.15	.	0.14	.	0.20	.
	0.26	0.15	0.12	0.12	0.13	0.13	.	0.15	.	0.18	.
AVE	0.22	0.23	0.11	0.13	0.13	0.14	.	0.15	.	0.19	.
1977 FORD LTD 49 STATE	0.43	0.28	0.22	0.33	0.42	0.51	0.45	0.43	0.75	1.81	1.31
	0.29	0.22	0.27	0.20	0.40	0.46	0.45	0.32	0.54	1.33	1.99
	0.27	.	.	.	.	.	.	.	.	.	.
AVE	0.33	0.25	0.24	0.27	0.41	0.49	0.45	0.38	0.64	1.57	1.65
1977 PLYMOUTH FURY 49S	0.24	0.21	0.18	0.15	0.06	0.12	.	0.11	.	0.29	.
	0.24	0.21	0.23	0.12	0.11	0.10	.	0.15	.	0.25	.
	.	.	.	0.14	0.09	.	.	.	.	.	.
AVE	0.24	0.21	0.21	0.14	0.09	0.11	.	0.13	.	0.27	.
1978 BUICK V6 TURBOCHARGE	0.17	0.15	0.15	0.09	0.11	0.10	0.11	0.12	0.13	0.28	0.16
	0.19	0.12	0.14	0.13	0.11	0.13	0.11	0.21	0.12	0.19	0.22
	0.20	.	.	.	.	.	.	.	.	.	.
AVE	0.19	0.13	0.14	0.11	0.11	0.12	0.11	0.17	0.12	0.23	0.19
1977 PLYMOUTH FURY CALIF	0.07	0.06	0.04	0.03	0.02	0.04	0.06	0.04	0.08	0.09	0.12
	0.07	0.05	0.02	0.06	0.05	0.03	0.06	0.04	0.08	0.23	0.17
	.	.	.	.	.	.	.	.	.	.	0.20
AVE	0.07	0.06	0.03	0.04	0.04	0.04	0.06	0.04	0.08	0.16	0.16
1978 CHEVROLET ST 4-CALIF	0.12	0.11	0.10	0.05	0.06	0.07	0.04	0.05	0.05	0.08	0.10
	0.15	0.14	0.10	0.06	0.07	0.06	0.08	0.05	0.04	0.12	0.13
AVE	0.13	0.13	0.10	0.06	0.06	0.06	0.06	0.05	0.05	0.10	0.11
1978 FORD PINTO CAL 3 WAY	0.08	0.17	0.07	0.14	0.08	0.08	0.14	0.09	0.09	0.08	0.07
	0.10	0.13	0.23	0.12	0.06	0.06	0.07	0.07	0.06	0.11	0.15
	0.11	.	.	.	.	.	.	0.05	.	.	0.11
AVE	0.10	0.15	0.15	0.13	0.07	0.07	0.11	0.07	0.07	0.10	0.11
1978 VW RABBIT CAL FU-INJ	0.06	0.06	0.06	0.07	0.09	0.18	.	0.35	.	0.85	.
	0.06	0.07	0.06	0.10	0.13	0.20	.	0.50	.	0.81	.
AVE	0.06	0.06	0.06	0.09	0.11	0.19	.	0.42	.	0.83	.
1979 DODGE ASPEN CALIF.	0.12	0.11	0.09	0.08	0.08	0.07	0.08	0.07	0.07	0.11	0.10
	0.11	0.10	0.12	0.09	0.11	0.09	0.08	0.07	0.08	0.10	0.07
AVE	0.12	0.11	0.10	0.09	0.09	0.08	0.08	0.07	0.07	0.10	0.09
1980 MERCURY PROTOTYPE	.	0.13	0.12	0.06	0.13	0.07	0.09	0.16	0.19	0.07	0.13
	.	0.18	.	.	0.09	0.12	.	.	.	0.09	0.20
AVE	.	0.15	0.12	0.06	0.11	0.09	0.09	0.16	0.19	0.08	0.17
1980 BUICK REGAL PROTOTYP	.	0.07	0.04	0.04	0.07	0.05	0.04	0.07	0.05	0.19	0.19
	.	0.06	.	.	0.04	0.04	.	.	.	0.07	0.14
AVE	.	0.06	0.04	0.04	0.06	0.04	0.04	0.07	0.05	0.13	0.16
DATSUN PROTOTYPE	0.09	0.07	0.08	0.09	0.06	0.07	.	0.06	.	0.05	.
	0.12	0.09	0.08	0.07	0.06	0.06	.	0.06	.	0.07	.
	.	.	0.08	.	.	.	.	.	.	.	.
AVE	0.10	0.08	0.08	0.08	0.06	0.06	.	0.06	.	0.06	.

TABLE 21 SULFATE EMISSION TEST - HYDROCARBONS G/KM

TEMPERATURE F (C)	0 (-18)	40 (4)	80 (27)	80AC (27)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	0.96	1.12	1.54	1.51	1.57	1.63
	1.05	1.19	1.33	1.13	1.71	1.55
AVE	1.01	1.16	1.43	1.32	1.64	1.59
1974 CHEVROLET IMPALA	1.04	1.34	1.48	.	1.80	.
	1.04	1.41	1.59	.	1.37	.
AVE	1.04	1.38	1.54	.	1.59	.
1977 HONDA CIVIC 49 STATE	0.60	0.32	0.40	.	0.52	.
	0.77	0.38	0.38	.	0.53	.
AVE	0.68	0.35	0.39	.	0.52	.
1977 FORD LTD 49 STATE	0.60	0.47	0.73	0.71	1.64	1.91
	0.58	0.57	0.70	0.72	1.46	2.77
	0.56	.	.	.	.	.
AVE	0.58	0.52	0.71	0.71	1.55	2.34
1977 PLYMOUTH FURY 49S	0.51	0.27	0.20	.	0.71	.
	0.33	0.43	0.22	.	0.57	.
AVE	0.42	0.35	0.21	.	0.64	.
1978 BUICK V6 TURBOCHARGE	0.26	0.23	0.14	0.23	0.83	0.62
	0.22	0.16	0.22	0.19	0.56	0.59
	0.25	.	.	.	.	.
AVE	0.24	0.20	0.18	0.21	0.69	0.60
1977 PLYMOUTH FURY CALIF	0.09	0.05	0.06	0.09	0.14	0.21
	0.08	0.04	0.07	0.12	0.36	0.23
	.	.	.	.	.	0.51
AVE	0.09	0.05	0.06	0.10	0.25	0.32
1978 CHEVROLET ST W-CALIF	0.11	0.12	0.08	0.06	0.13	0.09
	0.16	0.12	0.10	0.08	0.14	0.19
AVE	0.13	0.12	0.09	0.07	0.14	0.14
1978 FORD PINTO CAL 3 WAY	0.18	0.13	0.20	0.24	0.17	0.13
	0.19	0.34	0.11	0.13	0.23	0.26
	0.19	.	.	.	.	.
AVE	0.19	0.24	0.16	0.19	0.20	0.20
1978 VW RABBIT CAL FU-INJ	0.21	0.20	0.35	.	0.97	.
	0.20	0.21	0.35	.	0.99	.
AVE	0.20	0.20	0.35	.	0.98	.
1979 DODGE ASPEN CALIF.	0.17	0.13	0.12	0.13	0.17	0.18
	0.16	0.16	0.14	0.12	0.15	0.13
AVE	0.17	0.15	0.13	0.12	0.16	0.15
1980 MERCURY PROTOTYPE	.	0.20	0.13	0.17	0.15	0.20
	.	0.20	0.17	0.17	0.13	0.21
AVE	.	0.20	0.15	0.17	0.14	0.21
1980 BUICK REGAL PROTOTYP	.	0.04	0.07	0.05	0.19	0.28
	.	0.04	0.06	0.05	0.11	0.25
AVE	.	0.04	0.06	0.05	0.15	0.26
DATSUN PROTOTYPE	0.15	0.10	0.06	.	0.68	.
	0.12	0.09	0.08	.	0.10	.
	0.13	0.09	0.08	.	0.39	.
AVE	0.13	0.09	0.06	.	0.39	.

Federal Short Cycle - HC--

The Federal Short Cycle (FSC) was run on the first six cars tested as listed in Table 22. These tests were run with the car in the fully warmed up condition following the HFET. Again, it was observed that hydrocarbon emissions were the highest at the higher temperatures.

TABLE 22 FEDERAL SHORT CYCLE - HYDROCARBONS G/KM

	TEMPERATURE F	0	40	80	110
	(C)	(-18)	(4)	(27)	(43)
1972 CHEVROLET IMPALA		1.26	1.12	1.57	2.10
		1.12	1.30	1.91	2.15
	AVE	1.19	1.21	1.74	2.12
1974 CHEVROLET IMPALA		1.58	2.04	1.87	2.05
		1.16	1.70	2.30	1.48
	AVE	1.37	1.87	2.08	1.76
1977 FORD LTD		0.45	0.36	1.09	4.92
		0.40	0.34	0.71	4.44
		0.34	•	•	•
	AVE	0.40	0.35	0.90	4.68
1977 PLYMOUTH FURY 495		0.61	0.33	0.37	1.65
		0.68	0.55	0.26	1.48
	AVE	0.65	0.44	0.31	1.56
1977 PLYMOUTH FURY CALIF		0.09	0.12	0.06	0.46
		0.11	0.10	0.22	0.82
	AVE	0.10	0.11	0.15	0.64
1978 CHEVROLET ST W-CALIF		0.39	0.30	0.16	1.08
		0.49	0.33	0.21	0.19
	AVE	0.44	0.32	0.18	0.63

The 1977 Ford had surprisingly high emissions at 110°F (43°C). While the catalyst cars had generally lower hydrocarbon emissions, only the 1977 (California) Plymouth emissions approach the low levels achieved with the HFET or the SET procedures.

The FSC has been considered as a quick test to replace the FTP for inspection stations. Comparing data for the appropriate cars at 80°F (27°C) from Tables 19 and 22 shows that the results from FTP divided by results from the FSC gives ratios which vary widely. This indicates that the results from the two procedures do not agree well. The precatalyst cars, however, were in better agreement.

New York City Cycle - HC--

The FSC was replaced by the New York City Cycle (NYCC) procedure during the program. This NYCC procedure was designed to evaluate the emissions in severe stop and go driving. This procedure was run last in the sequence after stopping the engine for three minutes and then idling for three minutes. Data are presented in Table 23.

TABLE 23 NEW YORK CITY CYCLE - HYDROCARBONS G/KM

TEMPERATURE F (C)	20 (-7)	60 (16)	80 (27)	80AC (27)	110 (43)	110AC (43)
1977 HONDA CIVIC 49 STATE	2.40	2.37	2.32	.	2.80	.
	1.74	2.18	2.12	.	2.86	.
AVE	2.07	2.28	2.22	.	2.83	.
1978 BUICK V6 TURBOCHARGE	0.81	0.97	1.03	1.14	14.25	20.98
	0.89	1.88	0.77	3.30	4.21	3.32
AVE	0.85	1.43	0.90	2.22	9.23	12.15
1978 FORD PINTO CAL 3 WAY	1.02	0.73	1.06	1.02	3.46	2.23
	1.95	1.00	0.59	0.72	2.25	7.26
AVE	1.48	0.67	0.82	0.87	2.86	4.75
1978 VW RABBIT CAL FU-INJ	0.34	0.28	0.49	.	1.82	.
	0.40	0.42	0.45	.	1.96	.
AVE	0.37	0.35	0.47	.	1.89	.
1979 DODGE ASPEN CALIF.	1.20	0.81	0.79	0.80	1.19	1.26
	1.01	0.99	0.79	0.85	1.01	0.82
AVE	1.10	0.90	0.79	0.82	1.10	1.04
1980 MERCURY PROTOTYPE	0.79	0.37	0.61	0.43	0.61	0.49
	1.14	0.37	0.45	0.43	0.57	0.48
AVE	0.96	0.37	0.53	0.43	0.59	0.48
1980 BUICK REGAL PROTOTYP	0.39	0.15	0.20	0.19	0.22	1.10
	0.23	0.15	0.12	0.19	0.40	0.86
AVE	0.31	0.15	0.16	0.19	0.31	0.98
DATSUN PROTOTYPE	0.36	0.44	0.39	.	1.87	.
	0.53	0.46	0.36	.	1.19	.
AVE	0.45	0.42	0.37	.	1.53	.

This procedure gave emissions that were quite high in hydrocarbons. The Honda, the only noncatalyst car tested, generally gave hydrocarbon emissions that were several times higher than those observed using other test procedures.

Test temperature had little effect on the HC emissions from the Honda. The 1978 Buick turbocharged vehicle had surprisingly high emissions at 110°F (43°C) along with poor repeatability. The high emissions may be in part attributed to driveability problems. Only the 1979 Dodge, the 1980 Mercury prototype, and the 1980 Buick prototype showed temperature effects and they were small. Both Buicks and the Pinto hydrocarbon emissions increased when their air conditioner was operating at 110°F (43°C).

Federal 3 Mode - HC--

The next six tables present the hydrocarbon emission data obtained from the Federal 3 mode (F3M) procedure. These tests were conducted following the FSC tests. These tables compare the raw exhaust gas analyses obtained using a laboratory-type instrument equipped with a flame ionization detector with those obtained using a garage-type nondispersive IR instrument. While single values are reported for each test, the readings were not steady and a rough average estimate was used to establish a reading.

80 km/h (50 mph) loaded steady-state - hydrocarbons--Table 24 presents the results of tests conducted at 80 km/h (50 mph) and at a specified load. Each car at each speed had its own specified load. For the first three cars, the laboratory-type instrument (Beckman) gave higher readings than the garage-type (Stewart Warner) instrument. For the last three cars, the reverse was generally true.

TABLE 24 80 KM/H (50 MPH), LOADED, STEADY STATE - HYDROCARBONS PPMC6

TEMPERATURE F		0		40		80		110	
(C)		(-18)		(4)		(27)		(43)	
INSTRUMENT		B	SW	B	SW	B	SW	B	SW
1972 CHEVROLET IMPALA		14	35	127	35	205	93	298	90
		100	23	125	52	170	50	276	65
	AVE	57	29	126	44	188	72	287	78
1974 CHEVROLET IMPALA		46	30	197	28	135	52	107	42
		41	36	38	30	42	34	66	48
	AVE	44	33	118	29	89	43	87	45
1977 FORD LTD		57	31	38	40	212	89	312	112
		13	28	66	40	35	80	49	120
		81	20	•	•	•	•	•	•
	AVE	50	26	52	40	124	85	181	116
1977 PLYMOUTH FURY 49S		9	23	7	15	8	20	47	50
		10	20	9	15	8	22	15	22
	AVE	10	22	8	15	8	21	31	36
1977 PLYMOUTH FURY CALIF		2	30	3	20	3	22	8	18
		3	29	2	19	9	20	265	100
	AVE	3	30	3	20	6	21	137	59
1978 CHEVROLET ST W-CALIF		9	21	9	23	7	20	9	22
		9	21	14	23	4	14	34	20
	AVE	9	21	12	23	6	17	22	21

B = BECKMAN SW = STEWART WARNER

48 km/h (30 mph) loaded steady-state - hydrocarbons--Table 25 presents the hydrocarbon emissions from the cars which were run at 48 km/h (30 mph) and at a specified load. Some very large differences in hydrocarbon concentrations were observed with the 1974 Chevrolet. There was no evident reason for the poor repeatability observed here.

TABLE 25 48 KM/H (30 MPH), LOADED, STEADY STATE - HYDROCARBONS PPMC6

TEMPERATURE F	0		40		80		110	
(C)	(-18)		(4)		(27)		(43)	
INSTRUMENT	B	SW	B	SW	B	SW	B	SW
1972 CHEVROLET IMPALA	19	43	273	75	393	170	404	150
	126	32	241	78	260	100	333	100
AVE	72	38	257	77	326	135	369	125
1974 CHEVROLET IMPALA	49	31	117	42	2370	1200	104	48
	52	35	64	40	335	190	73	49
AVE	51	33	91	41	1353	695	89	49
1977 FORD LTD	14	10	14	10	14	20	316	121
	2	11	11	20	2	12	59	150
	12	10	•	•	•	•	•	•
AVE	9	10	13	15	8	16	188	136
1977 PLYMOUTH FURY 49S	14	23	10	18	33	35	216	200
	17	22	16	19	34	25	55	45
AVE	16	23	13	19	34	30	136	123
1977 PLYMOUTH FURY CALIF	8	28	10	24	7	23	9	18
	10	22	8	20	15	21	6	20
AVE	9	25	9	22	11	22	8	19
1978 CHEVROLET ST W-CALIF	6	18	5	19	5	15	8	20
	7	18	7	18	4	13	38	18
AVE	7	18	6	19	5	14	23	19

B = BECKMAN SW = STEWART WARNER

2500 rpm no load steady state - hydrocarbons--Table 26 presents the hydrocarbon concentrations found when the vehicles were operated at 2500 rpm with no load. Again, it is difficult to explain the differences between instruments which in some cases vary by a factor of six.

TABLE 26 2500 RPM, NO LOAD, STEADY STATE - HYDROCARBONS PPMC6

TEMPERATURE F		0		40		80		110	
(C)		(-18)		(4)		(27)		(43)	
INSTRUMENT		B	SW	B	SW	B	SW	B	SW
1972 CHEVROLET IMPALA		13	15	261	40	462	70	243	52
		55	13	190	40	282	60	304	50
	AVE	34	14	226	40	372	65	274	51
1974 CHEVROLET IMPALA		33	38	43	35	73	50	39	28
		40	28	51	35	47	42	35	32
	AVE	37	33	47	35	60	46	37	30
1977 FORD LTD		100	70	21	50	30	34	365	130
		9	60	34	35	4	20	63	120
		35	22	•	•	•	•	•	•
	AVE	48	51	26	43	17	27	214	125
1977 PLYMOUTH FURY 49S		50	45	17	22	20	20	260	250
		74	60	11	25	12	22	32	25
	AVE	62	53	14	24	16	21	146	138
1977 PLYMOUTH FURY CALIF		52	55	61	60	37	45	12	15
		62	60	67	75	26	25	16	20
	AVE	57	58	64	68	32	35	14	18
1976 CHEVROLET ST W-CALIF		67	62	31	50	12	20	13	20
		68	65	52	60	11	21	47	20
	AVE	68	64	42	55	12	21	30	20

B = BECKMAN SW = STEWART WARNER

Idle in drive steady state - hydrocarbons--Table 27 shows the hydrocarbon concentrations from measurements made with the engines idling and the automatic transmissions in drive. The 1977 Ford and the 1977 California Plymouth, in this case, had low hydrocarbon emissions while the 1977 49-State Plymouth exhibited significantly higher hydrocarbon emissions.

TABLE 27 IDLE, IN DRIVE, STEADY STATE - HYDROCARBONS PPMC6

TEMPERATURE	F (C)	0 (-18)		40 (4)		80 (27)		110 (43)	
INSTRUMENT		B	SW	B	SW	B	SW	B	SW
1972 CHEVROLET IMPALA		30	80	267	100	305	130	292	100
		203	74	241	95	247	90	466	150
	AVE	117	77	254	98	276	110	379	125
1974 CHEVROLET IMPALA		128	52	236	75	2726	1400	183	78
		161	59	159	80	619	400	171	80
	AVE	145	56	199	78	1673	900	177	79
1977 FORD LTD		8	11	10	11	6	30	56	50
		1	10	67	19	2	11	7	22
		8	9	•	•	•	•	•	•
	AVE	6	10	39	15	4	21	32	36
1977 PLYMOUTH FURY 49S		291	170	16	20	326	145	1059	850
		254	145	21	18	68	35	215	140
	AVE	273	158	20	19	197	90	637	495
1977 PLYMOUTH FURY CALIF		7	22	7	2	9	20	10	15
		7	20	8	15	10	18	13	18
	AVE	7	21	8	9	10	19	12	17
1976 CHEVROLET ST W-CALIF		7	17	7	17	5	11	3	15
		7	18	8	18	4	11	19	16
	AVE	7	18	8	18	5	11	11	16

B = BECKMAN SW = STEWART WARNER

Readings were erratic and at high concentrations the Stewart Warner instrument indicates lower hydrocarbon concentrations than the Beckman. At low concentrations, the reverse was true.

Idle in neutral steady state - hydrocarbons--Table 28 presents the hydrocarbon concentrations in idle in neutral taken before the 2500 rpm, no load condition. Table 29 gives the same data when measured after the 2500 rpm condition.

TABLE 28 IDLE IN NEUTRAL STEADY STATE* - HYDROCARBON PPMC6

TEMPERATURE F	0		40		80		110	
(C)	(-18)		(4)		(27)		(43)	
INSTRUMENT	B	SW	B	SW	B	SW	B	SW
1972 CHEVROLET IMPALA	72	250	310	60	355	100	374	120
	124	32	221	70	470	80	341	100
AVE	98	141	266	75	413	90	358	110
1974 CHEVROLET IMPALA	124	100	369	180	100	100	80	42
	94	100	371	230	727	410	76	82
AVE	109	100	370	205	414	255	78	62
1977 FORD LTD	36	25	29	25	19	22	133	90
	4	15	45	32	5	22	23	42
	44	25	•	•	•	•	•	•
AVE	28	22	37	29	12	22	78	66
1977 PLYMOUTH FURY 495	26	30	19	20	463	140	505	400
	24	25	19	19	168	80	218	100
AVE	25	28	19	20	316	110	362	250
1977 PLYMOUTH FURY CALIF	6	22	5	20	7	23	10	14
	9	21	17	21	9	21	15	20
AVE	8	22	11	21	8	22	13	17
1978 CHEVROLET ST W-CALIF	24	28	20	31	15	20	9	20
	20	28	30	30	10	18	105	25
AVE	22	28	25	31	13	19	57	23

*BEFORE 2500 RPM CONDITION B = BECKMAN SW = STEWART WARNER

TABLE 29 IDLE IN NEUTRAL STEADY STATE* - HYDROCARBON PPMC6

TEMPERATURE F	0		40		80		110	
(C)	(-18)		(4)		(27)		(43)	
INSTRUMENT	B	SW	B	SW	B	SW	B	SW
1972 CHEVROLET IMPALA	541	1750	310	90	437	130	430	90
	125	36	264	70	338	100	366	120
AVE	333	893	287	80	388	115	398	105
1974 CHEVROLET IMPALA	74	52	412	210	92	70	114	50
	119	50	288	200	796	230	228	82
AVE	97	51	350	205	444	150	171	66
1977 FORD LTD	34	21	10	28	22	30	365	79
	5	20	25	28	4	20	46	40
	10	12	•	•	•	•	•	•
AVE	16	16	18	28	13	25	206	60
1977 PLYMOUTH FURY 495	32	32	22	20	304	110	305	225
	29	27	22	28	121	35	61	40
AVE	31	30	22	24	213	73	183	133
1977 PLYMOUTH FURY CALIF	6	22	6	22	14	30	11	15
	15	25	10	29	20	32	14	20
AVE	11	24	8	26	17	31	13	18
1978 CHEVROLET ST W-CALIF	29	32	34	49	21	19	13	22
	8	20	36	35	21	29	162	40
AVE	19	26	35	42	21	24	87	31

*AFTER 2500 RPM CONDITION B = BECKMAN SW = STEWART WARNER

Carbon Monoxide (CO)

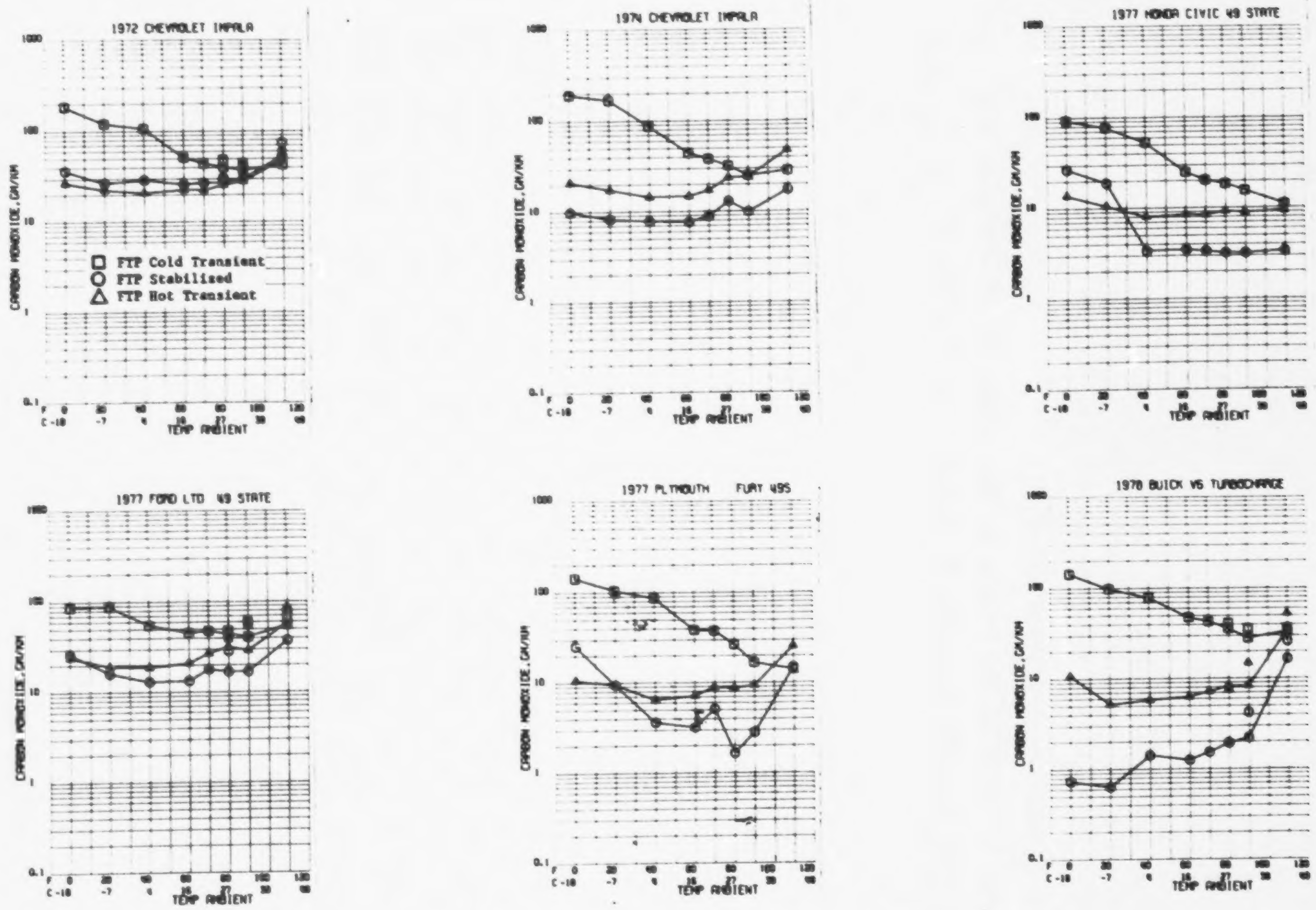
Figure 6 shows the average CO emissions, by car, for all three phases of the Federal test procedure plotted against test temperatures. Figure 7 presents similar plots of average CO emissions for the composite FTP as well as those for the HFET, the SET and either the NYCC or the FSC tests. The non-air conditioned car results have been connected by lines; the air-conditioned car data points stand alone. A semilogarithmic scale was used in these figures to compress the data because carbon monoxide showed a wide variation in emissions depending on the temperature and emission control system employed by the various cars.

Federal Test Procedure-Cold Transient-CO--

As shown in Table 30 and Figure 6, this phase of the FTP gave high

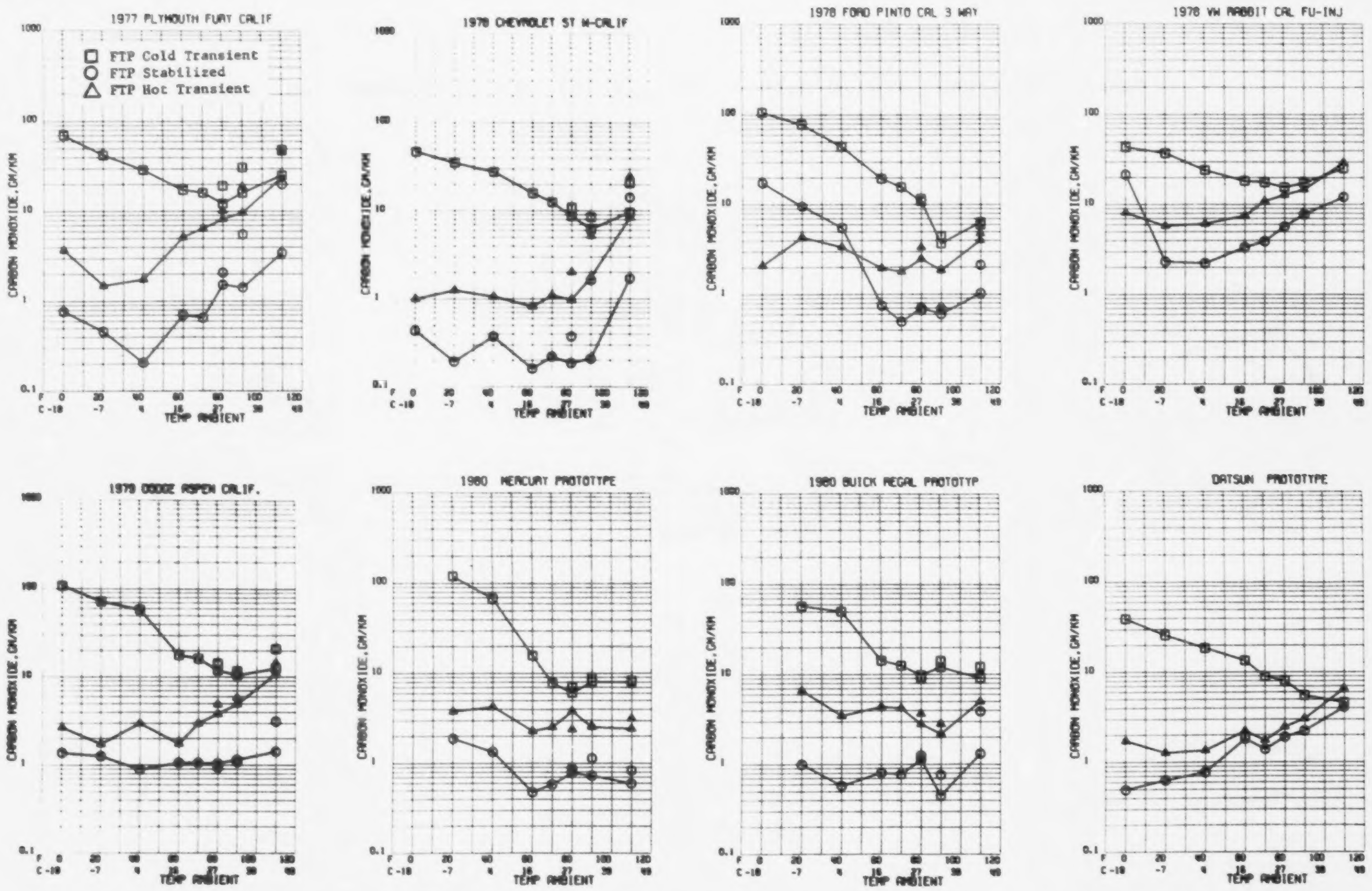
TABLE 30 F T P COLD TRANSIENT - CARBON MONOXIDE G/KM

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	184.56	91.92	75.83	48.91	41.41	35.96	45.70	35.17	42.41	38.00	46.72
	163.17	148.00	137.63	52.66	45.93	43.74	51.22	39.07	43.83	46.36	51.90
AVE	183.88	119.96	106.73	50.78	43.67	39.85	48.46	37.12	43.12	42.18	49.31
1974 CHEVROLET IMPALA	218.12	187.13	45.67	40.88	32.08	37.36	.	23.48	.	28.70	.
	166.01	150.27	128.19	44.17	43.58	26.09	.	26.22	.	27.34	.
	.	.	.	47.44	.	.	.	.	.	.	.
AVE	192.06	168.70	86.93	44.17	17.83	31.72	.	24.85	.	28.02	.
1977 HONDA CIVIC 49 STATE	89.96	76.77	26.65	23.83	20.85	17.68	.	16.13	.	11.17	.
	93.50	76.02	77.19	25.70	19.86	19.14	.	15.00	.	10.98	.
AVE	91.73	76.40	52.27	24.76	20.36	18.51	.	15.57	.	11.07	.
1977 FORD LTD 49 STATE	89.31	86.06	51.64	41.59	47.72	39.64	55.05	44.16	63.83	57.60	64.76
	76.74	89.76	57.78	48.49	46.93	48.34	41.13	36.90	54.70	51.39	69.08
	92.94	.	.	.	.	.	.	.	.	.	.
AVE	86.33	87.91	54.71	45.04	47.33	43.99	48.09	40.53	59.26	54.49	66.92
1977 PLYMOUTH FURY 49S	146.26	97.37	59.65	.	33.94	23.62	.	15.19	.	12.56	.
	137.28	111.99	112.24	46.79	46.01	29.17	.	18.13	.	15.49	.
	.	.	.	45.35	32.95	.	.	.	.	.	.
AVE	141.77	104.68	85.95	46.07	37.63	26.39	.	16.66	.	14.02	.
1978 BUICK V6 TURBOCHARGE	.	100.79	76.47	48.88	44.05	36.38	42.37	30.74	31.32	20.29	39.57
	137.37	94.68	80.78	45.88	41.74	34.55	40.01	25.06	39.65	45.07	31.66
	143.74	.	.	.	.	.	.	.	.	.	.
AVE	140.56	97.64	78.62	47.38	42.90	35.46	41.19	27.90	35.49	32.68	35.62
1977 PLYMOUTH FURY CALIF	67.94	41.67	28.06	18.21	11.75	10.70	22.09	15.47	26.47	21.66	30.86
	70.35	42.54	29.22	16.22	20.30	13.61	16.42	16.66	34.98	28.75	52.45
	.	.	.	.	.	.	.	.	.	.	62.49
AVE	69.15	42.10	28.64	17.21	16.02	12.15	19.26	16.66	30.72	25.21	48.60
1978 CHEVROLET ST W-CALIF	44.50	37.11	27.27	17.51	12.87	9.45	10.90	7.33	7.34	9.64	25.10
	48.58	32.38	27.87	14.10	12.27	7.70	11.00	4.91	9.49	9.64	16.18
AVE	46.52	34.74	27.57	15.80	12.57	8.58	10.95	6.12	8.42	9.64	20.64
1979 FORD PINTO CAL 3 WAY	96.01	76.04	20.95	19.66	17.24	12.83	14.92	4.60	4.48	5.64	4.97
	108.14	78.29	67.09	19.16	14.08	8.79	8.26	3.66	4.30	6.92	2.56
	110.49	.	.	.	.	.	.	2.63	.	.	10.03
AVE	104.88	77.17	44.02	19.41	15.66	10.81	11.60	3.63	4.39	6.28	5.86
1978 VW RABBIT CAL FU-INJ	43.54	41.19	25.06	17.36	16.71	15.48	.	15.50	.	22.87	.
	43.33	33.02	23.12	19.18	18.55	15.54	.	19.10	.	27.40	.
AVE	43.43	37.10	24.09	18.27	17.63	15.51	.	17.34	.	25.13	.
1979 DODGE ASPEN CALIF.	112.40	86.02	46.06	17.15	10.70	9.03	10.00	9.08	7.50	12.93	21.13
	102.92	57.10	70.22	18.38	21.75	14.68	18.57	11.87	15.86	12.08	20.69
AVE	107.66	71.56	58.14	17.77	16.23	11.86	14.28	10.48	11.68	12.51	20.91
1980 MERCURY PROTOTYPE	.	120.69	67.70	15.71	6.17	5.70	7.02	7.92	8.74	8.59	7.50
	.	117.26	.	.	9.18	6.26	.	.	.	7.27	8.98
AVE	.	118.98	67.70	15.71	7.68	5.98	7.02	7.92	8.74	7.93	8.24
1980 BUICK REGAL PROTOTYPE	.	63.34	50.03	14.21	13.98	10.20	9.07	12.03	14.12	9.04	11.67
	.	50.98	.	.	11.07	9.39	.	.	.	8.85	12.69
AVE	.	57.16	50.03	14.21	12.52	9.79	9.07	12.03	14.12	8.94	12.18
DATSUN PROTOTYPE	40.39	25.37	20.48	15.93	10.05	7.94	.	5.25	.	4.26	.
	37.45	26.05	.	11.08	7.71	8.05	.	5.67	.	4.84	.
	.	.	19.14	.	.	.	.	.	.	.	.
AVE	38.92	25.71	19.81	13.50	8.88	7.99	.	5.46	.	4.55	.



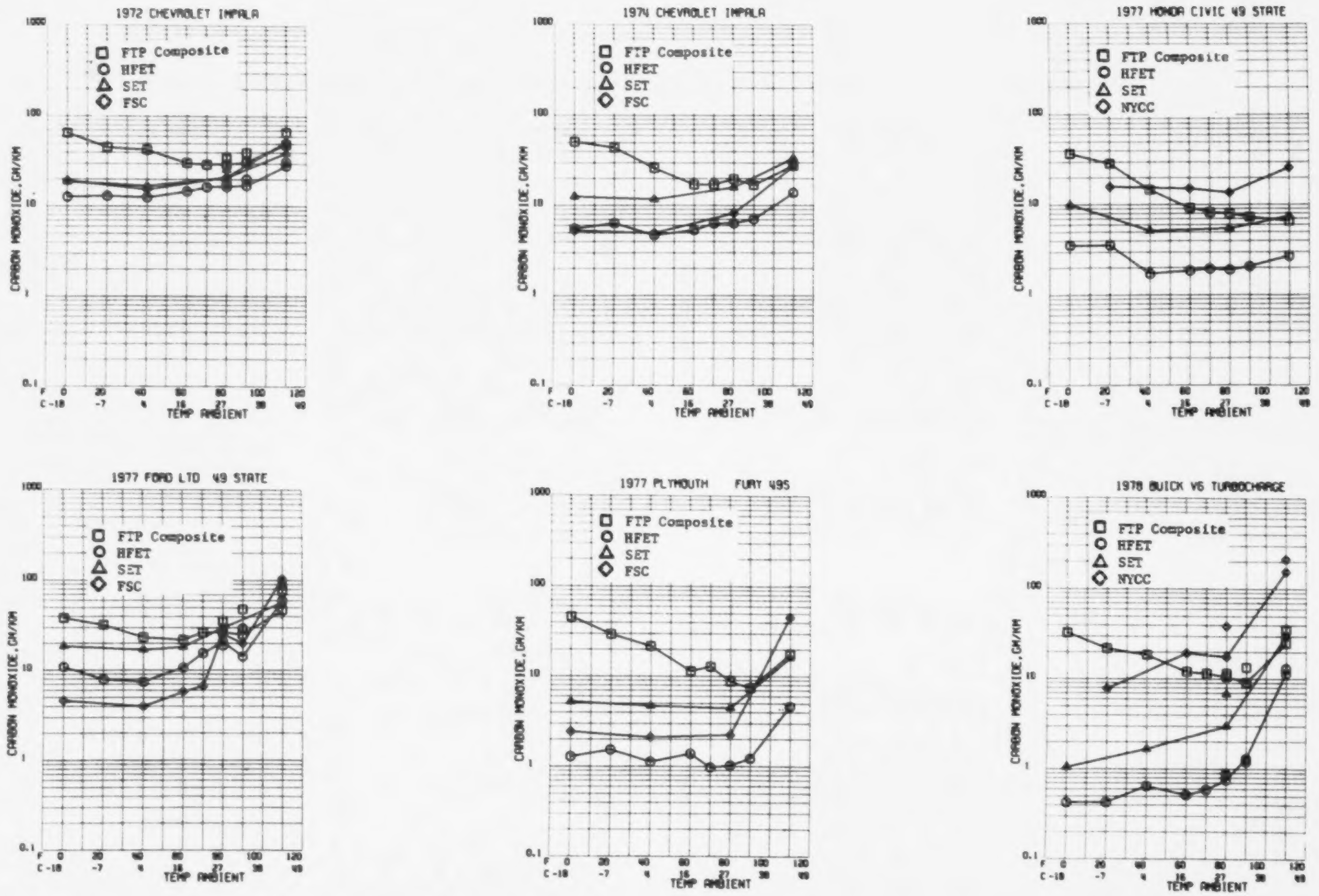
(Data points not connected by a line are the results of air conditioning runs.)

Figure 6. Effect of ambient temperature on carbon monoxide emissions for the three phases of the FTP.



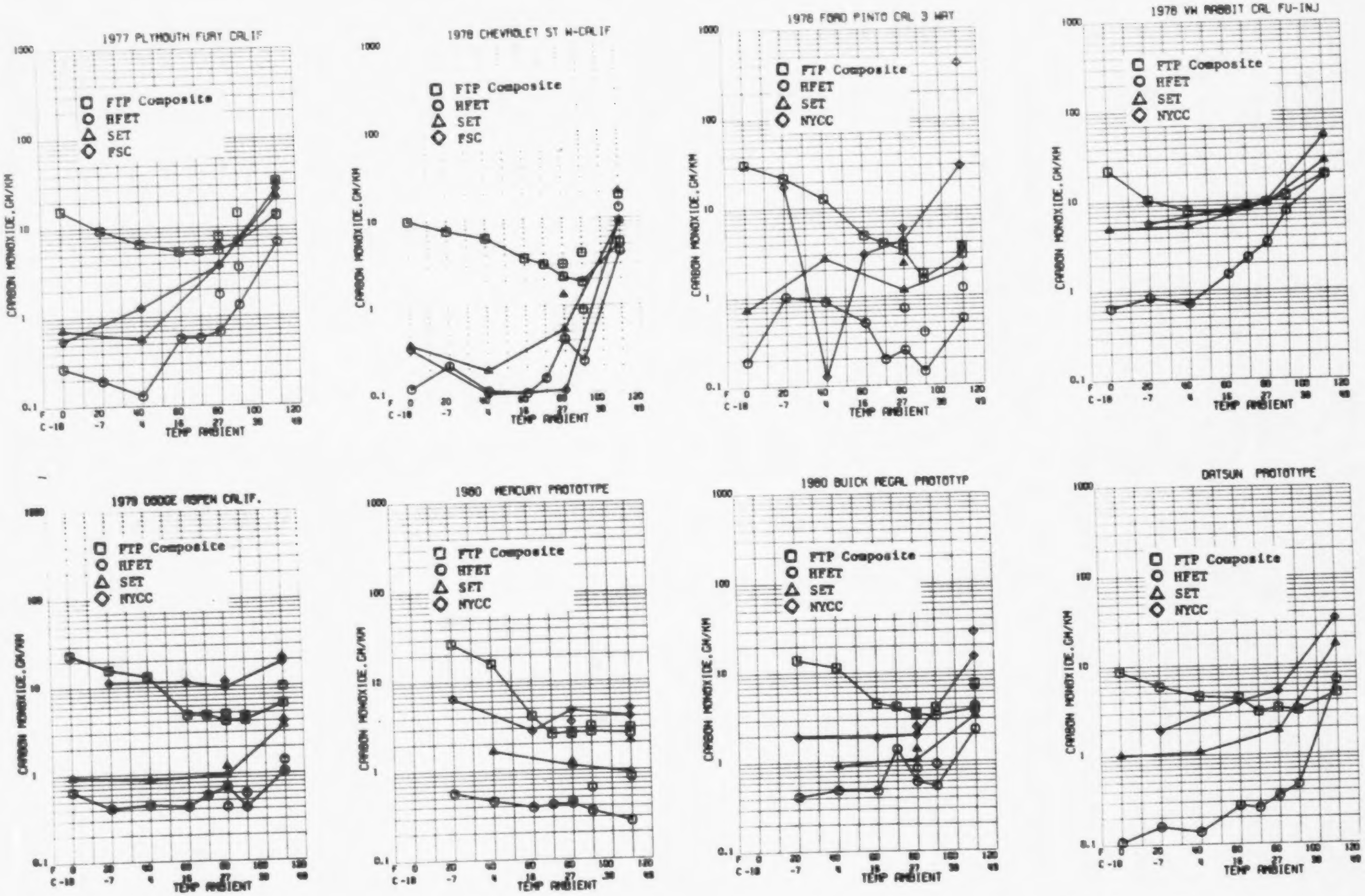
(Data points not connected by a line are the results of air conditioning runs.)

Figure 6. (continued)



(Data points not connected by a line are the results of air conditioning runs.)

Figure 7. Effect of ambient temperature on carbon monoxide emissions for the different test cycles.



(Data points not connected by a line are the results of air conditioning runs.)

Figure 7. (continued)

CO concentrations at 0 and 20°F (-18 and -7°C) for all of the cars. The 1980 prototype Mercury gave over 100 g/km of CO at 20°F (-4°C) despite an advanced catalyst system. CO was the highest for the two Chevrolet noncatalyst cars. The Honda, which was lower at 0 and 20°F (-18 and -7°C) than several of the catalyst cars, was also quite low at 110°F (43°C). The use of air conditioning usually increased CO, primarily as the result of increased load. The VW Rabbit showed the least change in CO emissions with ambient temperature. Overall, the Datsun prototype gave the lowest CO emissions for this cold transient phase of the FTP.

Federal Test Procedure-Stabilized Phase-CO--

This phase of the FTP (Table 31) gave some very low CO emissions.

TABLE 31 F T P STABILIZED - CARBON MONOXIDE G/KM

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	34.89	25.23	22.91	26.83	26.99	26.12	29.95	29.71	40.46	43.97	64.95
	38.02	28.03	34.99	24.97	26.69	28.35	31.21	29.23	40.31	61.21	82.96
AVE	36.46	26.63	28.95	25.90	26.84	27.23	30.58	29.47	40.38	52.59	73.96
1974 CHEVROLET IMPALA	9.53	8.22	7.65	6.69	7.65	10.61	.	7.66	.	20.17	.
	10.24	8.22	7.90	8.15	9.98	15.31	.	12.06	.	14.29	.
	.	.	.	7.94	.	.	.	.	.	.	.
AVE	9.88	8.22	7.77	7.59	8.81	12.96	.	9.86	.	17.23	.
1977 HONDA CIVIC 49 STATE	24.86	16.25	3.27	3.32	3.12	3.16	.	3.09	.	3.21	.
	28.65	21.53	3.46	3.58	3.53	3.19	.	3.22	.	3.47	.
AVE	26.75	18.89	3.36	3.45	3.32	3.17	.	3.16	.	3.34	.
1977 FORD LTD 49 STATE	29.36	14.68	11.37	14.34	15.53	15.52	26.88	18.05	45.71	40.47	75.02
	25.83	17.36	14.63	12.21	20.06	18.10	29.68	15.54	34.78	33.65	82.67
	23.42	.	.	.	.	.	.	.	.	.	.
AVE	26.20	16.02	13.00	13.28	17.79	16.81	28.28	16.79	40.24	37.06	78.85
1977 PLYMOUTH FURY 495	39.61	8.22	2.56	2.51	5.47	1.67	.	2.47	.	17.47	.
	11.06	10.50	4.60	4.20	8.54	1.61	.	3.07	.	12.25	.
	.	.	.	2.86	1.19	.	.	.	.	.	.
AVE	25.33	9.36	3.58	3.19	5.07	1.64	.	2.77	.	14.86	.
1978 BUICK V6 TURBOCHARGE	1.31	0.40	1.07	1.18	1.56	2.13	1.33	1.81	4.22	20.04	29.77
	0.47	0.87	1.75	1.32	1.49	1.74	2.53	2.56	4.16	13.49	22.25
	0.41	.	.	.	.	.	.	.	.	.	.
AVE	0.73	0.63	1.41	1.25	1.52	1.43	1.93	2.19	4.19	16.77	26.01
1977 PLYMOUTH FURY CALIF	0.36	0.66	0.21	0.50	0.25	2.01	1.43	1.01	6.07	2.54	6.82
	1.15	0.25	0.20	0.90	1.05	1.02	2.71	1.81	4.99	4.30	30.76
	.	.	.	.	.	.	.	.	.	.	22.74
AVE	0.76	0.46	0.20	0.70	0.65	1.52	2.07	1.81	5.53	3.42	20.11
1978 CHEVROLET ST W-CALIF	0.26	0.20	0.42	0.15	0.19	0.19	0.49	0.29	2.24	2.49	18.75
	0.61	0.19	0.33	0.17	0.25	0.18	0.25	0.12	1.01	0.92	9.96
AVE	0.44	0.19	0.37	0.16	0.22	0.19	0.37	0.21	1.63	1.71	14.36
1978 FORD PINTO CAL 3 WAY	2.82	1.66	0.19	0.58	0.63	1.14	1.10	0.96	0.94	0.70	2.36
	26.75	17.26	10.75	0.90	0.35	0.26	0.22	0.46	0.43	1.35	1.16
	22.71	.	.	.	.	.	.	0.36	.	.	2.82
AVE	17.42	9.46	5.47	0.74	0.49	0.70	0.66	0.60	0.68	1.02	2.12
1978 VW RABBIT CAL FU-INJ	11.44	2.73	2.78	3.03	3.51	5.90	.	6.09	.	12.02	.
	31.53	1.87	1.64	3.61	4.24	5.41	.	9.34	.	12.32	.
AVE	21.48	2.30	2.21	3.32	3.87	5.65	.	7.71	.	12.17	.
1979 DODGE ASPEN CALIF.	1.37	1.94	0.97	0.97	1.02	0.87	0.95	1.31	1.06	0.97	3.41
	1.37	0.57	0.79	1.14	1.06	1.20	0.91	0.97	1.09	1.85	2.83
AVE	1.37	1.25	0.88	1.05	1.05	1.03	0.93	1.14	1.08	1.41	3.12
1980 MERCURY PROTOTYPE	.	2.07	1.33	0.47	0.59	0.42	0.87	0.72	1.13	0.71	1.09
	.	1.66	.	.	0.57	1.13	.	.	.	0.47	0.55
AVE	.	1.86	1.33	0.47	0.58	0.77	0.87	0.72	1.13	0.59	0.82
1980 BUICK REGAL PROTOTYP	.	0.95	0.57	0.60	0.85	0.87	1.25	0.44	0.76	1.36	3.90
	.	1.04	.	.	0.68	1.38	.	.	.	1.26	3.83
AVE	.	0.99	0.57	0.80	0.77	1.12	1.25	0.44	0.76	1.31	3.86
DATSUN PROTOTYPE	0.59	0.78	0.81	1.96	1.69	1.66	.	2.04	.	4.10	.
	0.39	0.48	0.67	1.65	1.08	2.13	.	2.42	.	4.00	.
	.	.	0.82	.	.	.	.	.	.	.	.
AVE	0.49	0.63	0.77	1.81	1.38	1.89	.	2.23	.	4.05	.

Note that the 1978 (49 state) turbocharged Buick, the 1977 (California) Plymouth, the 1978 (California) Chevrolet, the 1979 (California) Dodge, the 1980 Mercury (prototype), the 1980 Buick (prototype) and the Datsun (prototype) all had CO emission of less than 2 g/km from 0 to 80°F (-18 to 27°C). However, rich operation as indicated by the high CO levels at the higher temperatures was evident in all cars, some more than others. At 110°F (43°C) the use of air conditioning often resulted in CO emissions that more than doubled.

The 1977 Ford may have had a catalyst problem or an air-fuel ratio problem. This is suggested by the high CO emission produced at all temperatures. Hydrocarbon emissions, Table 17, were not excessive for this car.

Federal Test Procedure-Hot Transient-CO--

Data in Table 32 show that the 10-minute soak and the startup still had an impact at reduced temperatures. Again, higher temperatures and particularly the use of air conditioners increased CO emissions. The 1977 Ford continued to have high CO emissions, as great as or greater than the 1974 Chevrolet without a catalyst. The 1978 Chevrolet had the lowest CO emissions at all temperatures other than 110°F (43°C) where several cars appeared to perform better. The 1980 Mercury (prototype) had the lowest CO emissions at 110°F (43°C), particularly with the air conditioners in operation.

TABLE 32   F T P HOT TRANSIENT   - CARBON MONOXIDE G/KM

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	25.19	22.39	18.38	24.13	22.33	24.52	27.95	28.82	31.98	40.02	52.62
	28.50	22.37	23.22	20.99	22.26	26.40	33.67	27.07	38.55	54.76	74.71
AVE	26.85	22.38	20.80	22.56	22.30	25.46	30.81	27.94	35.27	47.39	63.66
1974 CHEVROLET IMPALA	22.57	18.54	14.77	14.69	16.48	23.97	.	25.28	.	52.77	.
	19.44	16.30	14.21	13.87	17.83	23.09	.	23.11	.	41.52	.
	.	.	.	15.78	.	.	.	.	.	.	.
AVE	21.01	17.42	14.50	14.78	17.15	23.53	.	24.19	.	47.15	.
1977 HONDA CIVIC 49 STATE	13.55	11.69	7.21	7.38	8.34	10.19	.	9.31	.	9.37	.
	14.16	9.26	8.76	9.38	8.38	7.98	.	8.44	.	9.13	.
AVE	13.86	10.47	7.98	8.38	8.36	9.08	.	8.87	.	9.25	.
1977 FORD LTD 49 STATE	23.40	18.73	17.41	21.80	24.81	29.73	35.21	30.00	60.69	56.92	90.04
	25.15	19.66	20.00	19.92	28.77	33.42	37.35	27.58	45.40	59.16	83.58
	23.52	.	.	.	.	.	.	.	.	.	.
AVE	24.03	19.19	18.70	20.86	26.79	31.58	36.28	28.79	53.04	58.04	86.81
1977 PLYMOUTH FURY 49S	13.76	8.42	4.02	5.37	10.71	9.08	.	8.84	.	26.98	.
	7.51	10.39	8.85	8.02	9.18	8.12	.	9.70	.	23.98	.
	.	.	.	7.98	6.71	.	.	.	.	.	.
AVE	10.64	9.41	6.44	7.12	8.87	8.60	.	9.27	.	25.48	.
1978 BUICK V6 TURBOCHARGE	4.66	6.37	4.94	5.20	6.55	4.18	6.57	7.79	14.98	46.37	65.76
	12.12	4.00	6.62	7.33	7.68	12.39	8.68	8.64	14.76	22.67	39.03
	15.59	.	.	.	.	.	.	.	.	.	.
AVE	10.79	5.19	5.78	6.27	7.12	8.29	7.62	8.22	14.87	34.52	52.40
1977 PLYMOUTH FURY CALIF	3.23	1.48	1.55	3.54	5.58	8.16	8.97	10.19	19.45	21.35	31.06
	4.11	1.49	1.92	6.80	7.25	8.15	11.31	9.17	18.53	26.85	49.47
	.	.	.	.	.	.	.	.	.	.	55.42
AVE	3.67	1.48	1.73	5.17	6.42	8.15	10.14	9.17	18.99	24.10	45.32
1978 CHEVROLET ST W-CALIF	1.07	0.88	0.92	0.80	1.28	0.97	2.66	2.12	8.10	8.31	21.41
	0.94	1.62	1.19	0.82	0.91	0.98	1.35	1.36	2.25	8.51	28.08
AVE	1.00	1.25	1.06	0.81	1.10	0.98	2.01	1.74	5.17	8.41	24.74
1978 FORD PINTO CAL 3 WAY	1.04	0.81	0.64	1.84	2.04	3.18	4.55	3.42	2.12	3.01	5.29
	4.44	7.82	6.04	2.04	1.49	1.77	2.09	1.29	1.58	4.96	2.80
	0.77	.	.	.	.	.	.	0.79	.	.	6.10
AVE	2.09	4.31	3.34	1.94	1.77	2.47	3.32	1.83	1.85	3.99	4.73
1978 VW RABBIT CAL FU-INJ	6.82	6.11	6.46	6.16	10.83	13.61	.	13.22	.	28.20	.
	9.28	5.36	5.71	8.74	10.97	12.05	.	16.25	.	30.65	.
AVE	8.05	5.73	6.08	7.45	10.90	12.83	.	14.73	.	29.43	.
1979 DODGE ASPEN CALIF.	3.44	2.12	2.59	2.04	1.86	3.03	5.25	4.10	4.63	10.41	15.53
	1.89	1.33	3.34	1.44	4.08	4.56	4.57	5.68	6.96	11.26	13.30
AVE	2.67	1.73	2.96	1.74	2.97	3.80	4.91	4.89	5.80	10.83	14.41
1980 MERCURY PROTOTYPE	.	4.17	4.25	2.27	2.22	3.95	2.36	2.50	2.60	2.28	2.82
	.	3.34	.	.	2.79	3.60	.	.	.	2.53	3.46
AVE	.	3.75	4.25	2.27	2.50	3.77	2.36	2.50	2.60	2.41	3.14
1980 BUICK REGAL PROTOTYP	.	6.09	3.46	4.16	4.44	2.45	3.62	2.17	2.78	5.96	7.74
	.	7.07	.	.	3.92	3.09	.	.	.	3.93	13.72
AVE	.	6.58	3.46	4.16	4.18	2.77	3.62	2.17	2.78	4.94	10.73
DATSUN PROTOTYPE	1.86	1.12	1.63	2.21	1.87	2.05	.	3.20	.	6.82	.
	1.58	1.40	1.12	2.20	1.60	2.86	.	2.86	.	6.26	.
	.	.	1.29	.	.	.	.	.	.	.	.
AVE	1.72	1.26	1.34	2.21	1.74	2.45	.	3.03	.	6.54	.

Federal Test Procedure-Composite-CO--

Again the composite results are the basis for the standards previously shown in Table 15. The results shown in Table 33 should be within the emission standards at temperatures of 70 and 80°F (21 and 27°C). Most of the cars met their respective CO standard. These CO data repeated very well.

TABLE 33 F T P COMPOSITE - CARBON MONOXIDE G/KM

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	63.20	38.02	32.60	30.61	28.70	27.70	32.64	30.58	38.56	41.68	57.90
	65.63	51.60	52.04	29.57	29.43	30.96	35.98	30.67	40.55	56.38	74.33
AVE	64.42	44.81	42.32	30.09	29.06	29.33	34.31	30.62	39.56	49.03	66.12
1974 CHEVROLET IMPALA	56.25	47.78	17.43	15.90	15.06	19.75	•	15.70	•	30.78	•
	44.77	39.42	34.38	17.11	19.01	19.65	•	17.99	•	24.40	•
	•	•	•	18.20	•	•	•	•	•	•	•
AVE	50.51	43.60	25.90	17.07	17.03	19.70	•	16.84	•	27.59	•
1977 HONDA CIVIC 49 STATE	35.09	27.25	9.15	8.63	8.17	8.06	•	7.44	•	6.51	•
	38.00	29.32	20.04	9.66	8.16	7.76	•	7.05	•	6.54	•
AVE	36.55	28.29	14.60	9.15	8.16	7.91	•	7.25	•	6.52	•
1977 FORD LTD 49 STATE	40.02	30.47	21.32	21.97	24.65	24.33	35.90	26.69	53.53	48.45	76.99
	36.09	32.97	24.98	21.71	27.95	28.47	34.21	23.20	41.73	44.22	80.14
	37.91	•	•	•	•	•	•	•	•	•	•
AVE	38.01	31.72	23.15	21.84	26.30	26.40	35.06	24.94	47.63	46.34	78.57
1977 PLYMOUTH FURY 49S	54.81	26.81	14.89	7.36	12.72	8.19	•	6.80	•	19.04	•
	36.39	31.53	28.11	14.01	16.49	9.06	•	7.99	•	16.10	•
	•	•	•	12.91	9.17	•	•	•	•	•	•
AVE	45.60	29.17	21.50	11.43	12.79	8.62	•	7.40	•	17.57	•
1978 BUICK V6 TURBOCHARGE	32.03	22.59	17.57	11.97	11.58	9.67	11.15	9.33	12.69	27.29	41.51
	31.69	20.93	19.28	12.04	11.41	11.36	11.85	8.85	14.29	22.45	28.73
	33.91	•	•	•	•	•	•	•	•	•	•
AVE	32.54	21.76	18.43	12.00	11.50	10.52	11.50	9.09	13.49	24.87	35.12
1977 PLYMOUTH FURY CALIF	15.16	9.43	6.29	4.96	4.06	5.47	7.74	6.48	13.94	11.58	18.31
	16.31	9.41	6.71	5.64	6.69	5.57	7.85	6.88	14.86	15.48	40.27
	•	•	•	•	•	•	•	•	•	•	39.80
AVE	15.73	9.42	6.50	5.30	5.38	5.52	7.79	6.88	14.40	13.53	32.79
1978 CHEVROLET ST W-CALIF	9.65	7.98	6.07	3.88	3.10	2.31	3.22	2.22	4.88	5.56	20.77
	10.47	7.20	6.22	3.19	2.90	1.94	2.75	1.44	3.09	4.77	16.15
AVE	10.06	7.59	6.15	3.54	3.00	2.12	2.99	1.83	3.99	5.16	18.46
1978 FORD PINTO CAL 3 WAY	21.37	16.83	4.58	4.78	4.38	4.08	4.83	2.38	1.97	2.32	3.67
	37.38	27.22	20.98	4.91	3.46	2.40	2.37	1.33	1.53	3.47	1.88
	34.99	•	•	•	•	•	•	0.94	•	•	5.16
AVE	31.25	22.03	12.78	4.85	3.92	3.24	3.60	1.55	1.75	2.89	3.57
1978 VW RABBIT CAL FU-INJ	16.75	11.54	8.34	6.78	8.17	9.95	•	9.95	•	18.57	•
	27.92	9.21	7.16	8.17	9.00	9.28	•	13.21	•	20.39	•
AVE	22.34	10.37	7.75	7.47	8.59	9.61	•	11.58	•	19.48	•
1979 DODGE ASPEN CALIF.	24.57	19.38	10.66	4.59	3.21	3.12	3.97	3.66	3.34	5.97	10.29
	22.27	12.36	15.64	4.74	6.11	4.88	5.55	4.48	5.70	6.46	9.28
AVE	23.42	15.87	13.15	4.67	4.66	4.00	4.76	4.07	4.52	6.22	9.78
1980 MERCURY PROTOTYPE	•	27.29	15.86	4.06	2.16	2.44	2.52	2.67	3.07	2.72	2.86
	•	26.03	•	•	2.92	2.84	•	•	•	2.40	3.03
AVE	•	26.66	15.86	4.06	2.54	2.64	2.52	2.67	3.07	2.56	2.94
1980 BUICK REGAL PROTOTYP	•	15.17	11.52	4.50	4.51	3.21	3.51	3.26	4.03	4.15	6.51
	•	12.80	•	•	3.68	3.47	•	•	•	3.51	8.27
AVE	•	13.98	11.52	4.50	4.10	3.34	3.51	3.26	4.03	3.83	7.39
DATSUN PROTOTYPE	9.01	5.88	5.04	4.83	3.45	3.05	•	3.01	•	4.87	•
	8.25	5.92	3.88	3.73	2.57	3.54	•	3.20	•	4.78	•
	•	•	4.70	•	•	•	•	•	•	•	•
AVE	8.63	5.90	4.54	4.28	3.01	3.30	•	3.10	•	4.83	•

Highway Fuel Economy Test (HFET)-CO--

The effect of running the SET before the HFET at 0°F (-18°C) but not at 20°F (-7°C) thereby providing further engine warm-up at 0°F (-18°C) is shown in Table 34. In most cases, emissions at 0°F (-18°C) were less than or equal to those observed at 20°F (-7°C). Again, CO emissions were the greatest at 110°F (43°C) and higher with the air conditioners on. The 1977 Ford had the highest CO emissions at the higher temperatures.

The four California cars (excluding the VW) and the three prototype cars had the lowest CO emissions, particularly at temperatures of 90°F (32°C) and below. Some of these emissions were very low. Repeatability in this test, where the cars were well warmed up, was much improved.

TABLE 34 HIGHWAY FUEL ECONOMY TEST - CARBON MONOXIDE G/KM

TEMPERATURE F (C)		0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA		10.69	12.53	10.19	14.64	17.05	16.34	17.76	16.15	20.24	25.35	25.92
		14.72	13.50	14.86	14.43	15.81	16.80	18.18	17.80	19.81	30.82	36.67
	AVE	12.71	13.01	12.53	14.54	16.43	16.57	17.97	16.98	20.03	28.08	31.29
1974 CHEVROLET IMPALA		5.48	6.27	4.89	4.76	5.23	6.99	.	6.38	.	15.69	.
		5.42	6.28	4.37	5.76	7.31	5.62	.	7.56	.	11.93	.
		.	.	.	5.33	.	.	.	.	.	.	.
	AVE	5.45	6.28	4.63	5.28	6.27	6.30	.	6.97	.	13.81	.
1977 HONDA CIVIC 49 STATE		3.11	4.67	1.56	1.95	1.93	1.98	.	1.85	.	2.78	.
		3.93	2.38	1.86	1.73	1.95	1.80	.	2.25	.	2.57	.
	AVE	3.52	3.53	1.71	1.84	1.94	1.89	.	2.05	.	2.67	.
1977 FORD LTD 49 STATE		14.46	9.58	6.92	12.36	15.80	20.57	17.66	17.70	34.11	70.42	48.61
		9.75	6.00	7.82	9.00	15.24	21.16	19.81	10.70	24.56	48.68	100.41
		8.20	.	.	.	.	.	.	.	.	.	.
	AVE	10.80	7.79	7.37	10.68	15.52	20.87	18.83	14.20	29.34	59.55	74.51
1977 PLYMOUTH FURY 49S		1.54	1.79	0.93	1.20	1.03	1.03	.	0.92	.	5.23	.
		1.00	1.27	1.30	1.20	0.89	1.01	.	1.51	.	4.01	.
		.	.	.	1.73	0.99	.	.	.	.	.	.
	AVE	1.27	1.53	1.11	1.38	0.97	1.02	.	1.21	.	4.62	.
1978 BUICK V6 TURBOCHARGE		0.36	0.45	0.84	0.19	0.83	0.51	0.82	0.52	1.12	17.82	17.64
		0.70	0.40	0.45	0.83	0.33	1.00	0.92	2.07	1.25	5.31	8.61
		0.21	.	.	.	.	.	.	.	.	.	.
	AVE	0.42	0.42	0.64	0.51	0.58	0.75	0.87	1.29	1.19	11.57	13.12
1977 PLYMOUTH FURY CALIF		0.23	0.18	0.13	0.40	0.45	0.72	1.50	1.11	3.83	6.02	10.71
		0.30	0.21	0.12	0.75	0.70	0.63	2.03	1.56	3.28	7.36	13.48
		.	.	.	.	.	.	.	.	.	.	16.25
	AVE	0.27	0.19	0.13	0.57	0.58	0.67	1.77	1.56	3.55	6.69	13.48
1978 CHEVROLET ST W-CALIF		0.09	0.11	0.14	0.06	0.11	0.52	0.40	0.21	0.98	3.78	14.83
		0.15	0.33	0.08	0.07	0.19	0.30	0.44	0.25	0.79	4.48	11.71
	AVE	0.12	0.22	0.11	0.06	0.15	0.41	0.42	0.23	0.88	4.13	13.27
1978 FORD PINTO CAL 3 WAY		0.13	0.22	0.07	0.65	0.26	0.31	1.31	0.13	0.54	0.53	0.48
		0.10	1.82	1.71	0.36	0.13	0.18	0.16	0.17	0.24	0.57	1.96
		0.34	.	.	.	.	.	.	0.12	.	.	1.22
	AVE	0.19	1.02	0.89	0.50	0.19	0.25	0.73	0.14	0.39	0.55	1.22
1978 VW RABBIT CAL FU-INJ		0.66	0.73	0.74	1.22	1.93	3.42	.	5.85	.	20.43	.
		0.60	0.93	0.69	1.80	2.70	3.35	.	9.44	.	17.93	.
	AVE	0.63	0.83	0.72	1.51	2.32	3.39	.	7.64	.	19.18	.
1979 DODGE ASPEN CALIF.		0.63	0.64	0.44	0.46	0.41	0.41	0.42	0.42	0.48	1.09	2.08
		0.65	0.18	0.45	0.38	0.72	0.98	0.41	0.40	0.69	0.99	0.72
	AVE	0.64	0.41	0.44	0.42	0.57	0.69	0.41	0.41	0.59	1.04	1.40
1980 MERCURY PROTOTYPE		.	0.61	0.46	0.38	0.24	0.30	0.44	0.34	0.63	0.32	1.27
		.	0.52	.	.	0.58	0.55	.	.	.	0.21	0.38
	AVE	.	0.57	0.46	0.38	0.41	0.42	0.44	0.34	0.63	0.27	0.82
1980 BUICK REGAL PROTOTYP		.	0.52	0.48	0.47	2.18	0.61	0.84	0.53	0.94	3.07	4.70
		.	0.30	.	.	0.57	0.58	.	.	.	1.48	3.67
	AVE	.	0.41	0.48	0.47	1.38	0.59	0.84	0.53	0.94	2.28	4.18
DATSUN PROTOTYPE		0.11	0.21	0.16	0.31	0.29	0.34	.	0.50	.	10.93	.
		0.10	0.10	0.14	0.22	0.21	0.36	.	0.42	.	2.61	.
		.	.	0.11	.	.	.	.	.	.	.	.
	AVE	0.11	0.16	0.14	0.27	0.25	0.35	.	0.46	.	6.77	.

Sulfate Emission Test-CO--

The SET test, which was run following the FTP and after a three-minute engine idle period, showed higher CO emissions (Table 35) than the HFET but generally lower CO emissions than the hot transient phase of the FTP. This test is operated at higher speeds and faster accelerations than the HFET which may in part account for higher CO emissions. Again, the 1977 Ford had exceptionally high CO emissions and again the higher temperatures and the operation of the air conditioner usually increased the CO emissions.

TABLE 35 SULFATE EMISSION TEST - CARBON MONOXIDE G/KM

	TEMPERATURE F	0	40	80	80AC	110	110AC
	(C)	(-18)	(4)	(27)	(27)	(43)	(43)
1972 CHEVROLET IMPALA		16.73	14.23	20.92	26.14	33.93	35.83
		20.62	19.44	20.70	25.31	44.09	56.51
	AVE	18.67	16.83	20.81	25.72	39.01	46.17
1974 CHEVROLET IMPALA		12.24	11.98	19.07	.	35.74	.
		12.91	11.42	12.72	.	31.39	.
	AVE	12.57	11.70	15.89	.	33.57	.
1977 HONDA CIVIC 49 STATE		9.59	4.54	5.60	.	7.23	.
		10.45	5.74	5.25	.	7.52	.
	AVE	10.02	5.14	5.43	.	7.38	.
1977 FORD LTD 49 STATE		20.18	16.22	29.75	29.36	58.14	81.37
		18.02	17.61	29.49	30.87	55.73	116.81
		17.20	.	.	.	.	.
	AVE	18.47	16.92	29.62	30.11	56.93	99.09
1977 PLYMOUTH FURY 49S		6.48	3.91	3.98	.	18.00	.
		3.92	5.44	4.85	.	14.35	.
	AVE	5.20	4.67	4.42	.	16.17	.
1978 BUICK V6 TURBOCHARGE		1.73	1.77	2.02	8.02	37.31	37.39
		0.60	1.56	3.94	5.59	22.52	24.55
		0.81	.	.	.	.	.
	AVE	1.04	1.66	2.98	6.80	29.92	30.97
1977 PLYMOUTH FURY CALIF		0.85	0.46	3.89	5.32	16.88	22.34
		0.59	0.63	3.61	7.68	27.61	33.51
		.	.	.	.	.	38.99
	AVE	0.72	0.55	3.75	6.50	22.25	31.62
1978 CHEVROLET ST W-CALIF		0.26	0.12	0.66	1.70	10.32	19.44
		0.51	0.25	0.41	0.95	7.68	21.32
	AVE	0.38	0.19	0.53	1.33	9.00	20.38
1978 FORD PINTO CAL 3 WAY		0.59	0.35	1.59	3.56	1.48	1.69
		1.00	5.03	0.73	1.10	2.58	5.29
		0.61	.	.	.	.	.
	AVE	0.73	2.69	1.16	2.33	2.03	3.49
1978 VW RABBIT CAL FU-INJ		5.02	5.13	9.76	.	27.52	.
		4.86	5.39	9.03	.	27.78	.
	AVE	4.94	5.26	9.39	.	27.65	.
1979 DODGE ASPEN CALIF.		0.92	0.76	0.91	1.30	3.46	5.42
		0.94	0.96	1.00	1.09	3.52	2.71
	AVE	0.93	0.86	0.96	1.20	3.49	4.07
1980 MERCURY PROTOTYPE		.	1.66	0.81	1.24	1.01	2.84
		.	1.66	1.43	1.24	0.85	1.37
	AVE	.	1.66	1.12	1.24	0.93	2.11
1980 BUICK REGAL PROTOTYP		.	0.91	1.12	1.37	4.06	6.78
		.	0.91	0.99	1.37	2.41	6.67
	AVE	.	0.91	1.06	1.37	3.24	6.72
DATSUN PROTOTYPE		1.20	1.12	1.50	.	28.99	.
		0.83	1.09	2.19	.	5.03	.
		1.01	0.99	1.84	.	17.01	.
	AVE	1.01	1.07	1.84	.	17.01	.

New York City Cycle-CO--

Table 36 summarizes the CO emissions obtained using the NYCC, a cycle made up largely of idle conditions plus several sharp accelerations and decelerations. Even the California cars and the prototype cars have significant CO emissions when operated on this cycle. The Honda was the only noncatalyst car tested using this cycle.

This cycle, run with a warmed-up engine, gave several times the CO emissions obtained with the HFET cycle. The Honda, with its modified combustion system and no catalyst, was equal to many of the catalyst cars and much better than some at 110°F (43°C).

TABLE 36 NEW YORK CITY CYCLE - CARBON MONOXIDE G/KM

TEMPERATURE F (C)	20 (-7)	60 (16)	80 (27)	80AC (27)	110 (43)	110AC (43)
1977 HONDA CIVIC 49 STATE	17.90	16.55	14.57	.	28.59	.
	13.84	13.83	12.80	.	23.15	.
AVE	15.87	15.19	13.68	.	25.87	.
1978 BUICK V6 TURBOCHARGE	5.65	16.74	18.14	37.10	194.19	293.18
	9.90	22.26	17.17	40.44	117.72	133.78
AVE	7.78	19.50	17.66	38.77	155.95	213.48
1978 FORD PINTO CAL 3 WAY	1.85	2.98	5.66	7.46	32.65	30.81
	33.76	3.02	2.78	4.09	25.71	798.37
AVE	17.81	3.00	4.22	5.78	29.18	414.59
1978 VW RABBIT CAL FU-INJ	5.19	6.67	10.12	.	55.51	.
	6.13	9.32	9.56	.	50.46	.
AVE	5.66	8.00	9.84	.	52.98	.
1979 DODGE ASPEN CALIF.	12.16	8.26	10.32	10.38	20.38	26.13
	10.73	14.44	9.21	12.65	17.30	16.09
AVE	11.44	11.35	9.76	11.52	18.84	21.11
1980 MERCURY PROTOTYPE	6.13	2.78	5.60	3.50	3.57	5.98
	6.91	2.78	3.79	3.50	4.42	3.78
AVE	6.52	2.78	4.70	3.50	3.99	4.88
1980 BUICK REGAL PROTOTYP	2.32	1.67	2.34	2.47	19.31	36.37
	1.53	1.87	1.65	2.47	10.75	20.66
AVE	1.92	1.87	1.99	2.47	15.03	28.51
DATSUN PROTOTYPE	1.92	3.86	4.82	.	35.58	.
	1.89	4.02	5.39	.	31.10	.
AVE	1.90	3.94	5.11	.	33.34	.

Federal Short Cycle-CO--

Table 37 shows the CO emissions obtained using the FSC, a cycle designed for fast analysis of vehicle emissions. Of most interest is its correlation with the FTP. In general, the CO emissions obtained with the FSC were much lower than FTP composite values at temperatures below 110°F (43°C). At 110°F (43°C) CO emissions were very high.

TABLE 37 FEDERAL SHORT CYCLE - CARBON MONOXIDE G/KM

TEMPERATURE F		0	40	80	110
	(C)	(-18)	(4)	(27)	(43)
1972 CHEVROLET IMPALA		18.85	11.75	23.29	46.08
		19.54	19.05	18.92	58.03
	AVE	19.19	15.40	21.10	52.06
1974 CHEVROLET IMPALA		5.31	5.67	9.80	34.65
		5.11	4.12	6.50	19.72
	AVE	5.21	4.90	8.15	27.19
1977 FORD LTD		5.18	3.24	29.16	99.55
		6.15	4.62	21.36	110.55
		2.37	.	.	.
	AVE	4.56	3.93	25.26	105.05
1977 PLYMOUTH FURY 49S		2.97	1.39	2.87	52.73
		1.87	2.80	1.59	37.80
	AVE	2.42	2.10	2.23	45.27
1977 PLYMOUTH FURY CALIF		0.94	1.39	3.01	28.62
		0.15	1.11	4.42	24.81
	AVE	0.54	1.25	3.71	26.81
1978 CHEVROLET ST W-CALIF		0.15	0.10	0.14	11.54
		0.54	0.10	0.07	7.32
	AVE	0.34	0.10	0.11	9.43

Federal 3 Mode-CO--

The test conditions of the F3M were selected to find high emitters of either CO or hydrocarbons. Only the idle tests and 2500 rpm, no load tests do not require a dynamometer.

80 km/h (50 mph), loaded, steady state-CO--Data obtained at this condition are shown in Table 38. Since CO is measured by the Non-Dispersive Infrared (NDIR) principle in both the Beckman and Stewart Warner instruments, it is not surprising that the results are generally in good agreement.

TABLE 38 80 KM/H (50 MPH), LOADED, STEADY STATE - CARBON MONOXIDE %

TEMPERATURE F (C)		0 (-18)		40 (4)		80 (27)		110 (43)	
INSTRUMENT		B	SW	B	SW	B	SW	B	SW
1972 CHEVROLET IMPALA		0.40	0.40	0.90	0.95	1.50	1.60	1.51	0.53
		0.62	0.65	1.05	1.25	1.15	1.10	2.70	2.80
	AVE	0.51	0.52	0.97	1.10	1.32	1.35	2.10	1.66
1974 CHEVROLET IMPALA		0.65	0.68	0.40	0.18	2.28	2.00	1.55	1.45
		0.41	0.72	0.40	0.50	1.00	0.80	1.40	1.53
	AVE	0.53	0.70	0.40	0.34	1.64	1.40	1.47	1.49
1977 FORD LTD		0.77	0.55	1.00	0.52	1.60	1.74	4.15	4.20
		0.85	0.82	0.85	0.70	2.12	2.00	3.80	1.03
		0.95	0.73	0.92	0.61	1.86	1.87	3.97	2.61
	AVE	0.86	0.70	•	•	•	•	•	•
1977 PLYMOUTH FURY 49S		0.02	0.02	0.03	0.02	0.01	0.02	0.04	0.02
		0.04	0.03	0.02	0.02	0.02	0.03	0.02	0.01
	AVE	0.03	0.02	0.03	0.02	0.02	0.02	0.03	0.01
1977 PLYMOUTH FURY CALIF		0.02	0.04	0.08	0.02	0.00	0.02	0.10	0.08
		0.01	0.03	0.01	0.02	0.05	0.03	6.05	6.30
	AVE	0.01	0.03	0.04	0.02	0.03	0.02	3.07	3.19
1978 CHEVROLET ST W-CALIF		0.02	0.02	0.01	0.02	0.01	0.04	0.01	0.02
		0.01	0.02	0.01	0.02	0.02	0.01	0.00	0.02
	AVE	0.01	0.02	0.01	0.02	0.02	0.02	0.01	0.02

B = BECKMAN SW = STEWART WARNER

48 km/h (30 mph), loaded, steady state-CO--Data obtained at this condition are shown in Table 39. With a few exceptions, the results obtained with the two instruments were in good agreement.

TABLE 39 48 KM/H (30 MPH), LOADED, STEADY STATE - CARBON MONOXIDE %

TEMPERATURE F (C)		0 (-18)		40 (4)		80 (27)		110 (43)	
INSTRUMENT		B	SW	B	SW	B	SW	B	SW
1972 CHEVROLET IMPALA		0.45	0.50	2.45	3.00	3.80	1.00	3.15	0.85
		0.60	0.70	1.57	1.70	2.00	2.20	4.50	4.20
	AVE	0.52	0.60	2.01	2.35	2.90	1.60	3.82	2.52
1974 CHEVROLET IMPALA		0.10	0.03	0.12	0.13	2.58	1.51	1.00	0.75
		0.09	0.02	0.08	0.10	0.12	0.15	0.86	0.58
	AVE	0.09	0.02	0.10	0.11	1.35	0.83	0.93	0.66
1977 FORD LTD		0.05	0.03	0.25	0.03	0.08	0.09	4.08	3.60
		0.02	0.03	0.02	0.03	0.02	0.03	2.78	0.34
		0.02	0.03	0.13	0.03	0.05	0.06	3.43	1.97
	AVE	0.03	0.03	•	•	•	•	•	•
1977 PLYMOUTH FURY 495		0.02	0.02	0.02	0.02	0.20	0.01	0.80	0.60
		0.03	0.02	0.02	0.01	0.01	0.01	0.02	0.01
	AVE	0.02	0.02	0.02	0.01	0.10	0.01	0.41	0.30
1977 PLYMOUTH FURY CALIF		0.01	0.02	0.08	0.01	0.00	0.02	0.06	0.07
		0.01	0.03	0.01	0.03	0.02	0.02	0.10	0.05
	AVE	0.01	0.02	0.04	0.02	0.01	0.02	0.08	0.06
1978 CHEVROLET ST W-CALIF		0.01	0.02	0.01	0.02	0.01	0.04	0.01	0.01
		0.01	0.01	0.01	0.02	0.02	0.00	0.00	0.01
	AVE	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01

B = BECKMAN SW = STEWART WARNER

2500 rpm, no load, steady state-CO--In most cases, as shown in Table 40, the Beckman results agreed well with those of the Stewart Warner instrument. Repeatability was rather poor at the higher concentrations.

TABLE 40 2500 RPM, NO LOAD, STEADY STATE - CARBON MONOXIDE PERCENT

TEMPERATURE F		0		40		80		110	
(C)		(-18)		(4)		(27)		(43)	
INSTRUMENT		B	SW	B	SW	B	SW	B	SW
1972 CHEVROLET IMPALA		0.20	0.80	3.05	3.40	6.80	4.20	2.60	0.72
		0.90	0.85	2.35	2.23	3.50	3.40	3.75	3.30
	AVE	0.55	0.82	2.70	2.81	5.15	3.80	3.17	2.01
1974 CHEVROLET IMPALA		0.09	0.12	0.11	0.13	0.42	0.53	0.45	0.46
		0.10	0.05	0.06	0.12	0.10	0.13	0.56	0.59
	AVE	0.09	0.08	0.08	0.12	0.26	0.33	0.50	0.52
1977 FORD LTD		0.05	0.03	0.05	0.03	0.01	0.03	2.31	1.60
		0.02	0.03	0.02	0.03	0.03	0.03	2.45	0.53
		0.02	0.03	•	•	•	•	•	•
	AVE	0.03	0.03	0.03	0.03	0.02	0.03	2.38	1.06
1977 PLYMOUTH FURY 49S		0.04	0.03	0.03	0.02	0.01	0.02	2.15	2.00
		0.03	0.02	0.02	0.02	0.02	0.03	0.04	0.01
	AVE	0.03	0.02	0.02	0.02	0.02	0.02	1.09	1.00
1977 PLYMOUTH FURY CALIF		0.01	0.02	0.18	0.01	0.01	0.02	0.10	0.07
		0.01	0.01	0.01	0.01	0.02	0.02	0.14	0.18
	AVE	0.01	0.01	0.09	0.01	0.01	0.02	0.12	0.12
1978 CHEVROLET ST W-CALIF		0.02	0.02	0.01	0.02	0.01	0.02	0.01	0.02
		0.01	0.02	0.01	0.02	0.02	0.02	0.00	0.01
	AVE	0.01	0.02	0.01	0.02	0.02	0.02	0.01	0.01

B = BECKMAN SW = STEWART WARNER

Idle, in drive, steady state,-CO--Data for this condition are shown in Table 41. Again, there is good agreement between the Beckman and Stewart Warner results. Except at higher concentration levels, repeatability was good.

TABLE 41 IDLE, IN DRIVE, STEADY STATE - CARBON MONOXIDE PERCENT

TEMPERATURE F		0		40		80		110	
(C)		(-18)		(4)		(27)		(43)	
INSTRUMENT		B	SW	B	SW	B	SW	B	SW
1972 CHEVROLET IMPALA		0.58	0.55	4.00	3.20	2.00	2.50	1.50	0.63
		0.54	0.50	1.40	1.15	1.15	0.99	4.00	4.20
	AVE	0.56	0.52	2.70	2.17	1.57	1.74	2.75	2.41
1974 CHEVROLET IMPALA		0.30	0.27	0.19	0.22	3.25	2.60	0.36	0.50
		0.20	0.15	0.13	0.20	0.12	0.30	1.45	0.71
	AVE	0.25	0.21	0.16	0.21	1.68	1.45	0.91	0.60
1977 FORD LTD		0.01	0.03	0.05	0.03	0.03	0.03	0.14	0.23
		0.02	0.03	0.02	0.03	0.03	0.03	0.10	0.03
		0.02	0.03	•	•	•	•	•	•
	AVE	0.02	0.03	0.03	0.03	0.03	0.03	0.12	0.13
1977 PLYMOUTH FURY 495		1.30	1.30	0.02	0.02	1.68	1.70	3.05	3.00
		1.05	1.10	0.02	0.01	0.85	0.40	0.80	0.80
	AVE	1.17	1.20	0.02	0.01	1.26	1.05	1.92	1.90
1977 PLYMOUTH FURY CALIF		0.01	0.02	0.08	0.00	0.00	0.02	0.02	0.01
		0.01	0.02	0.01	0.02	0.02	0.01	0.01	0.00
	AVE	0.01	0.02	0.04	0.01	0.01	0.01	0.02	0.00
1978 CHEVROLET ST W-CALIF		0.01	0.02	0.01	0.02	0.01	0.03	0.01	0.01
		0.01	0.01	0.01	0.02	0.02	0.01	0.00	0.01
	AVE	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01

B = BECKMAN SW = STEWART WARNER

Idle, in neutral, steady state,-CO--This condition was measured both before and after the 2500 rpm condition. The results are shown in Tables 42 and 43. The agreement between the first and second tests was reasonably good.

TABLE 42 IDLE, IN NEUTRAL, STEADY STATE* - CARBON MONOXIDE PERCENT

TEMPERATURE F		0		40		80		110	
(C)		(-18)		(4)		(27)		(43)	
INSTRUMENT		B	SW	B	SW	B	SW	B	SW
1972 CHEVROLET IMPALA		0.31	0.30	2.80	3.40	2.80	3.40	1.51	0.55
		0.38	0.45	1.45	1.60	0.75	0.87	2.90	3.20
	AVE	0.34	0.37	2.12	2.50	1.77	2.13	2.20	1.87
1974 CHEVROLET IMPALA		0.15	0.02	0.16	0.22	1.50	0.72	0.50	0.45
		0.14	0.03	0.12	0.15	0.25	0.30	0.90	0.63
	AVE	0.14	0.02	0.14	0.18	0.88	0.51	0.70	0.54
1977 FORD LTD		0.05	0.03	0.01	0.03	0.03	0.03	0.12	0.10
		0.02	0.03	0.02	0.03	0.01	0.03	0.10	0.03
		0.02	0.03	.	.	.	.	.	.
	AVE	0.03	0.03	0.01	0.03	0.02	0.03	0.11	0.06
1977 PLYMOUTH FURY 495		0.02	0.01	0.02	0.02	3.15	2.25	3.15	3.10
		0.03	0.01	0.02	0.02	0.60	0.52	0.58	0.50
	AVE	0.02	0.01	0.02	0.02	1.87	1.38	1.86	1.80
1977 PLYMOUTH FURY CALIF		0.01	0.02	0.08	0.01	0.02	0.02	0.02	0.01
		0.01	0.01	0.01	0.02	0.02	0.01	0.00	0.00
	AVE	0.01	0.01	0.04	0.01	0.02	0.01	0.01	0.00
1978 CHEVROLET ST W-CALIF		0.01	0.02	0.01	0.02	0.01	0.03	0.01	0.02
		0.01	0.02	0.01	0.01	0.02	0.01	0.00	0.01
	AVE	0.01	0.02	0.01	0.01	0.02	0.02	0.01	0.01

TABLE 43 IDLE, IN NEUTRAL, STEADY STATE**- CARBON MONOXIDE PERCENT

TEMPERATURE F		0		40		80		110	
(C)		(-18)		(4)		(27)		(43)	
INSTRUMENT		B	SW	B	SW	B	SW	B	SW
1972 CHEVROLET IMPALA		0.26	0.30	2.70	2.80	2.95	3.20	1.00	1.02
		0.35	0.40	1.30	1.10	1.65	1.80	1.45	1.80
	AVE	0.30	0.35	2.00	1.95	2.30	2.50	1.22	1.41
1974 CHEVROLET IMPALA		0.12	0.22	0.16	0.21	1.04	0.82	1.10	1.05
		0.13	0.14	0.11	0.18	0.20	0.23	0.56	0.59
	AVE	0.12	0.18	0.13	0.19	0.62	0.52	0.83	0.82
1977 FORD LTD		0.05	0.03	0.01	0.03	0.02	0.03	0.50	0.03
		0.02	0.03	0.02	0.03	0.01	0.03	0.02	0.03
		0.02	0.03	.	.	.	.	.	.
	AVE	0.03	0.03	0.01	0.03	0.01	0.03	0.26	0.03
1977 PLYMOUTH FURY 495		0.04	0.05	0.02	0.02	1.20	1.10	1.15	1.20
		0.03	0.02	0.02	0.02	0.58	0.50	0.07	0.10
	AVE	0.03	0.03	0.02	0.02	0.89	0.80	0.61	0.65
1977 PLYMOUTH FURY CALIF		0.01	0.02	0.18	0.02	0.00	0.02	0.05	0.03
		0.01	0.02	0.01	0.02	0.02	0.02	0.01	0.02
	AVE	0.01	0.02	0.09	0.02	0.01	0.02	0.03	0.02
1978 CHEVROLET ST W-CALIF		0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02
		0.01	0.02	0.01	0.02	0.02	0.02	0.00	0.01
	AVE	0.01	0.02	0.01	0.02	0.02	0.02	0.01	0.01

*BEFORE 2500 RPM CONDITION

**AFTER 2500 RPM CONDITION

B = BECKMAN SW = STEWART WARNER

Nitrogen Oxide (NOX)

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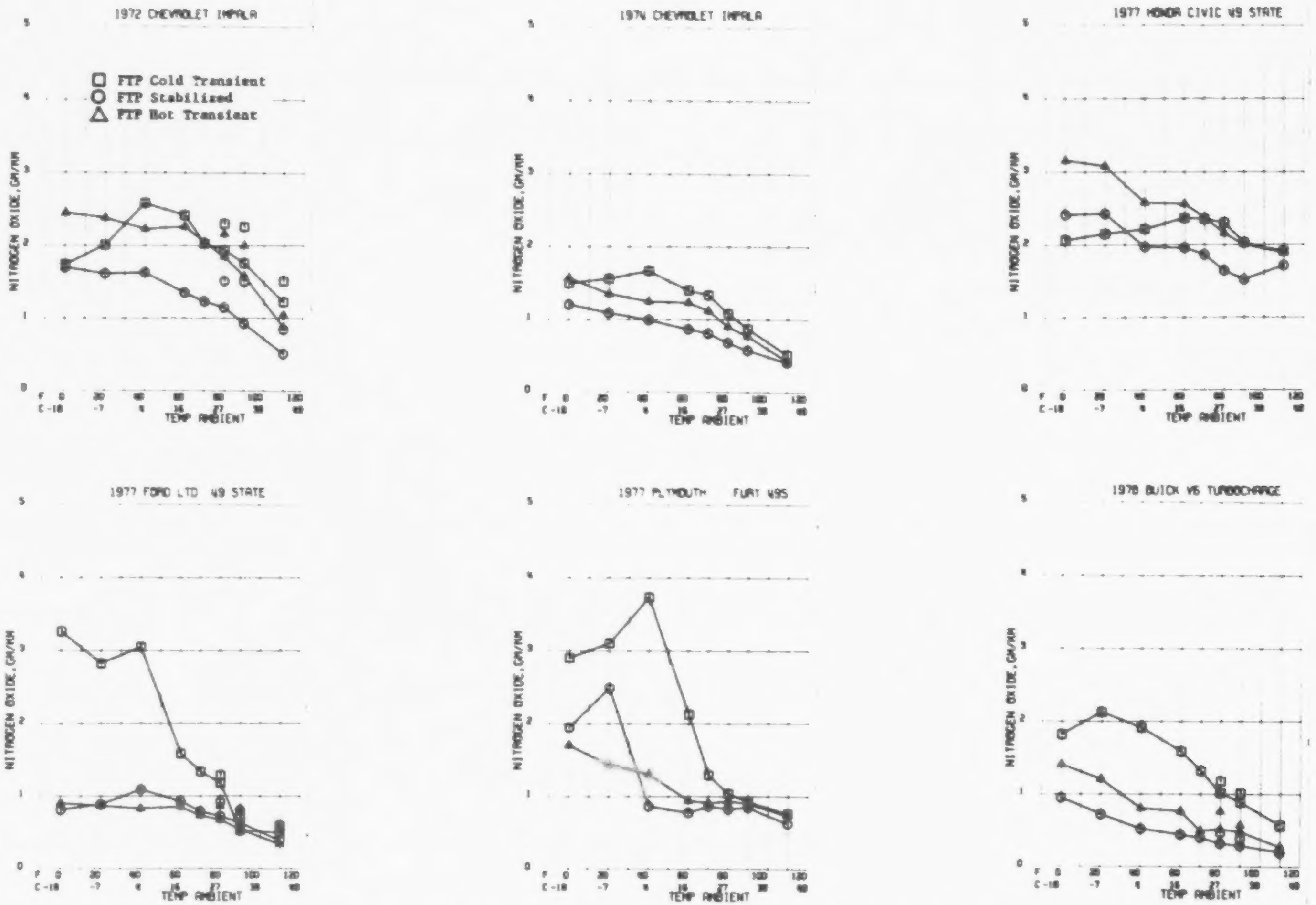
Figure 8 shows the uncorrected nitrogen oxide (NOX) emissions plotted against ambient temperatures from each of the three phases of the FTP. Figure 9 presents similar plots of the uncorrected NOX emissions for the composite FTP, HFET, SET and either the NYCC or the FSC tests procedures. Figures 10 and 11 show the NOX data after applying a humidity correction. The applicability of the current humidity correction factor at temperatures outside those normal for the FTP is questionable.

Federal Test Procedure-Cold Transient-NOX--

Table 44 lists the measured NOX emissions in g/km for the cold

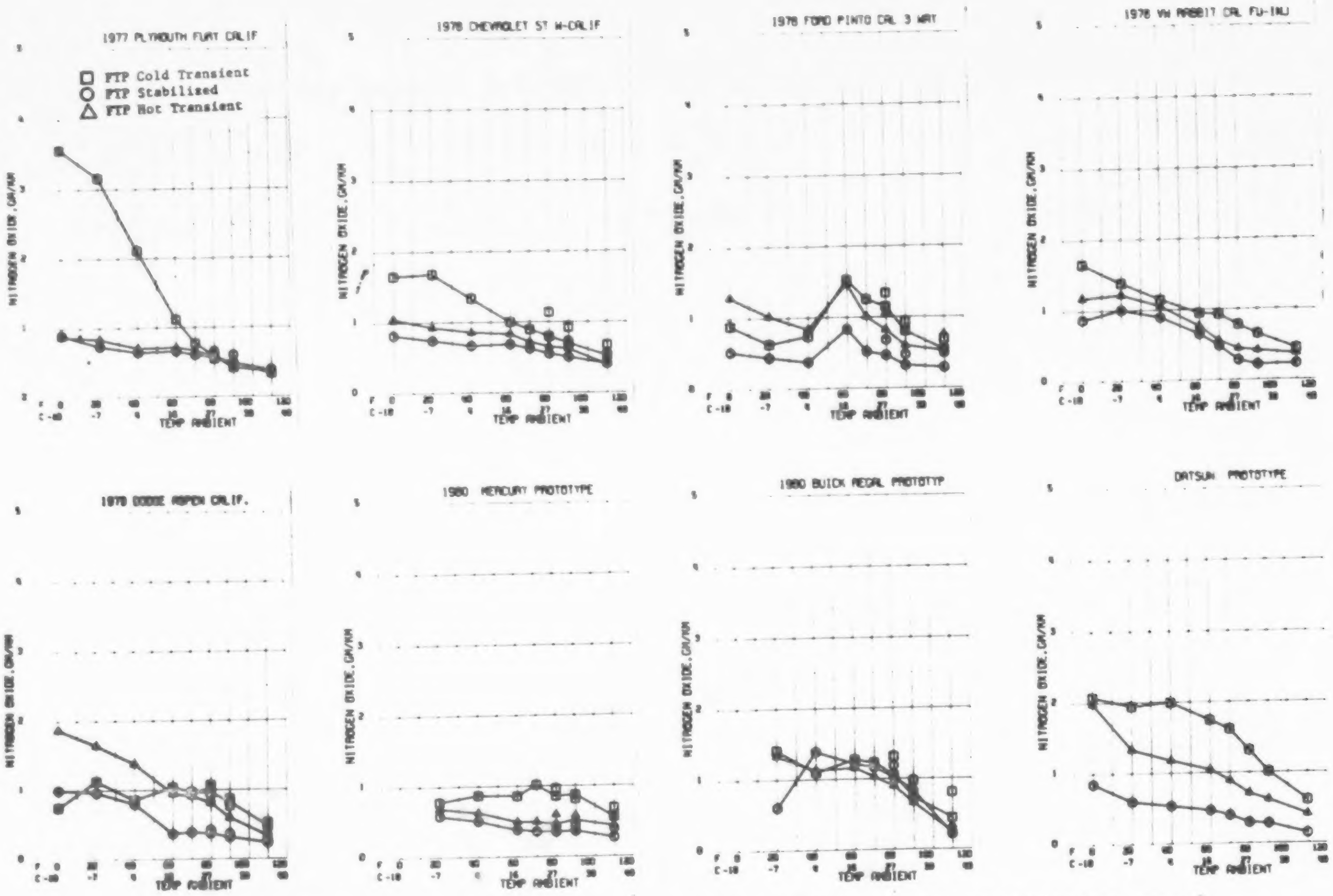
TABLE 44 F T P COLD TRANSIENT - NITROGEN OXIDES G/KM

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	1.77	1.87	2.38	2.34	2.19	2.16	2.53	2.00	2.49	1.35	1.62
	1.65	2.14	2.78	2.48	1.85	1.71	2.07	1.51	2.03	1.10	1.41
AVE	1.71	2.01	2.58	2.41	2.02	1.94	2.30	1.75	2.26	1.22	1.51
1974 CHEVROLET IMPALA	1.14	1.43	1.99	1.31	1.38	1.10	.	0.89	.	0.64	.
	1.84	1.68	1.34	1.48	1.29	1.06	.	0.86	.	0.39	.
	.	.	.	1.40	.	.	.	.	.	.	.
AVE	1.49	1.56	1.67	1.40	1.33	1.08	.	0.87	.	0.52	.
1977 HONDA CIVIC 49 STATE	2.18	1.88	2.79	2.27	2.27	2.25	.	2.04	.	1.94	.
	1.94	2.42	1.63	2.45	2.43	2.33	.	2.01	.	1.87	.
AVE	2.06	2.15	2.21	2.36	2.35	2.29	.	2.02	.	1.90	.
1977 FORD LTD 49 STATE	2.83	2.95	3.09	1.61	1.26	1.23	1.32	0.52	0.70	0.55	0.60
	3.57	2.70	3.01	1.54	1.42	1.12	1.24	0.52	0.67	0.43	0.57
	3.38	.	.	.	.	.	.	.	.	.	.
AVE	3.26	2.82	3.05	1.58	1.34	1.18	1.28	0.52	0.69	0.49	0.59
1977 PLYMOUTH FURY 49S	2.71	3.34	2.39	.	1.21	0.92	.	0.87	.	0.76	.
	3.09	2.87	5.08	1.74	1.26	1.15	.	0.97	.	0.75	.
	.	.	.	1.52	1.40	.	.	.	.	.	.
AVE	2.90	3.10	3.74	1.63	1.29	1.03	.	0.92	.	0.76	.
1978 BUICK V6 TURBOCHARGE	.	1.98	1.95	1.54	1.30	1.05	1.15	0.81	0.99	0.55	0.46
	1.96	2.27	1.88	1.63	1.33	0.98	1.20	0.96	1.02	0.60	0.66
	1.64	.	.	.	.	.	.	.	.	.	.
AVE	1.80	2.13	1.91	1.58	1.31	1.01	1.17	0.88	1.01	0.57	0.56
1977 PLYMOUTH FURY CALIF	3.57	3.03	2.25	1.22	0.82	0.60	0.49	0.44	0.42	0.34	0.35
	3.56	1.28	1.96	1.00	0.71	0.56	0.60	0.34	0.41	0.37	0.26
	.	.	.	.	.	.	.	.	.	.	0.37
AVE	3.56	3.16	2.10	1.11	0.77	0.58	0.54	0.39	0.42	0.36	0.33
1978 CHEVROLET ST W-CALIF	1.51	1.84	1.48	0.99	0.86	0.81	1.17	0.71	0.84	0.50	0.67
	1.78	1.51	1.18	1.01	0.92	0.78	1.09	0.68	0.99	0.53	0.68
AVE	1.65	1.68	1.33	1.00	0.89	0.79	1.13	0.70	0.92	0.52	0.67
1978 FORD PINTO CAL 3 WAY	0.78	0.64	0.80	1.50	1.20	1.16	1.34	.	0.97	0.45	0.64
	0.89	0.62	0.67	1.55	1.30	1.14	1.34	0.81	0.88	0.61	0.61
	1.01	.	.	.	.	.	.	0.79	.	.	0.79
AVE	0.89	0.63	0.74	1.52	1.25	1.15	1.34	0.80	0.93	0.53	0.68
1978 VW RABBIT CAL FU-INJ	1.65	1.29	1.12	0.89	0.94	0.85	.	0.69	.	0.48	.
	1.65	1.47	1.18	0.99	0.92	0.70	.	0.61	.	0.40	.
AVE	1.65	1.38	1.15	0.94	0.93	0.78	.	0.65	.	0.44	.
1979 DODGE ASPEN CALIF.	0.73	0.77	0.92	0.95	0.84	0.85	1.00	0.72	0.77	0.43	0.51
	0.77	1.49	0.79	1.11	1.09	1.07	1.14	0.92	0.96	0.52	0.53
AVE	0.75	1.13	0.86	1.03	0.97	0.96	1.07	0.82	0.86	0.47	0.52
1980 MERCURY PROTOTYPE	.	0.75	0.87	0.86	0.93	0.81	0.96	0.87	0.81	0.59	0.69
	.	0.80	.	.	1.09	0.89	.	.	.	0.52	0.68
AVE	.	0.77	0.87	0.86	1.01	0.85	0.96	0.87	0.81	0.55	0.69
1980 BUICK REGAL PROTOTYP	.	1.28	1.09	1.27	1.19	1.05	1.32	0.73	0.96	0.52	0.77
	.	1.53	.	.	1.27	1.05	.	.	.	0.36	0.83
AVE	.	1.41	1.09	1.27	1.23	1.05	1.32	0.73	0.96	0.44	0.80
DATSUN PROTOTYPE	1.99	1.84	1.87	1.75	1.63	1.34	.	1.02	.	0.68	.
	2.15	2.04	.	1.72	1.60	1.29	.	0.99	.	0.53	.
	.	.	1.96	.	.	.	.	.	.	.	.
AVE	2.07	1.94	1.92	1.74	1.61	1.31	.	1.01	.	0.61	.



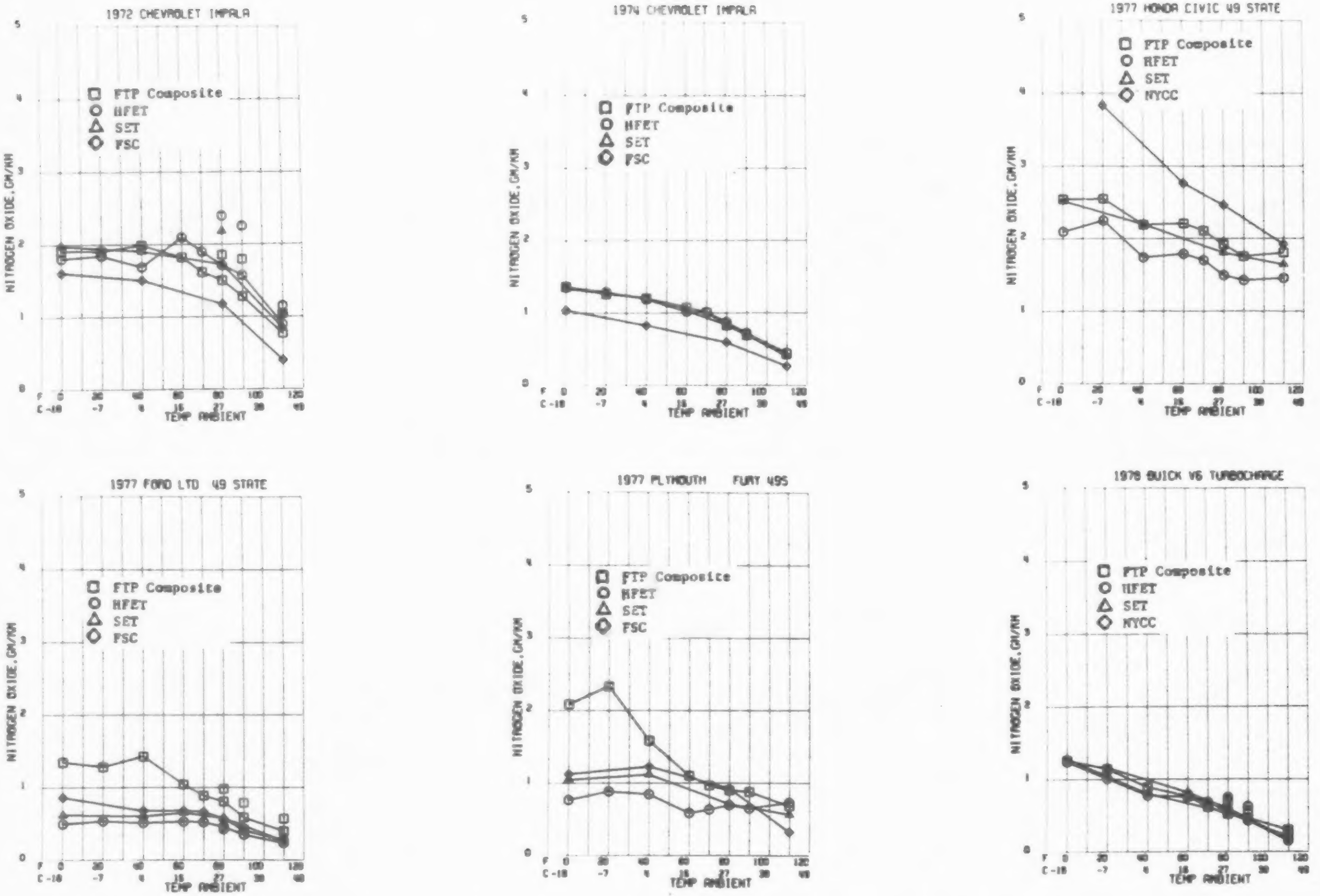
(Data points not connected by a line are the results of air conditioning runs.)

Figure 8. Effect of ambient temperature on uncorrected nitrogen oxide emissions for the FTP.



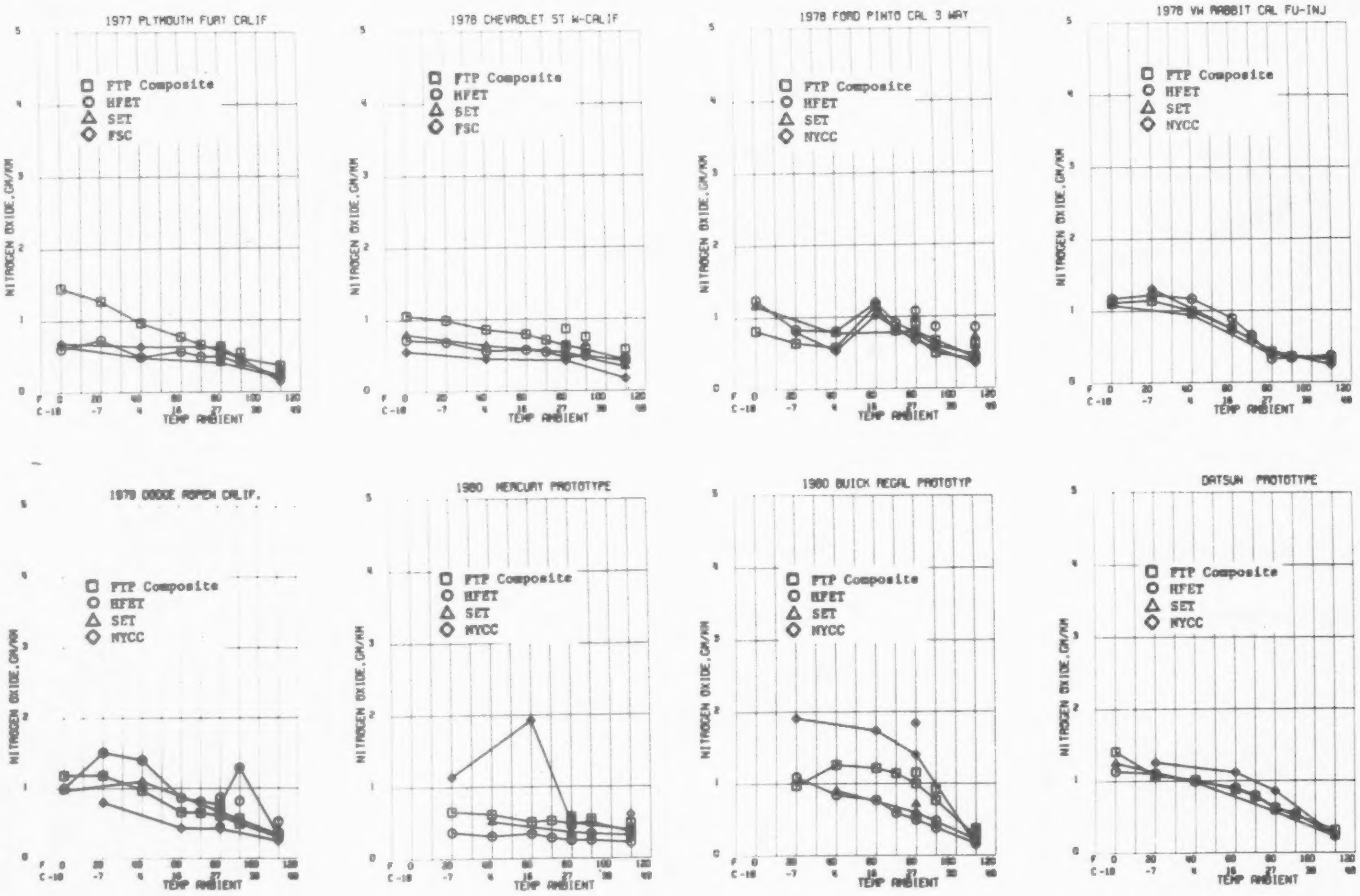
(Data points not connected by a line are the results of air conditioning runs.)

Figure 8. (continued)



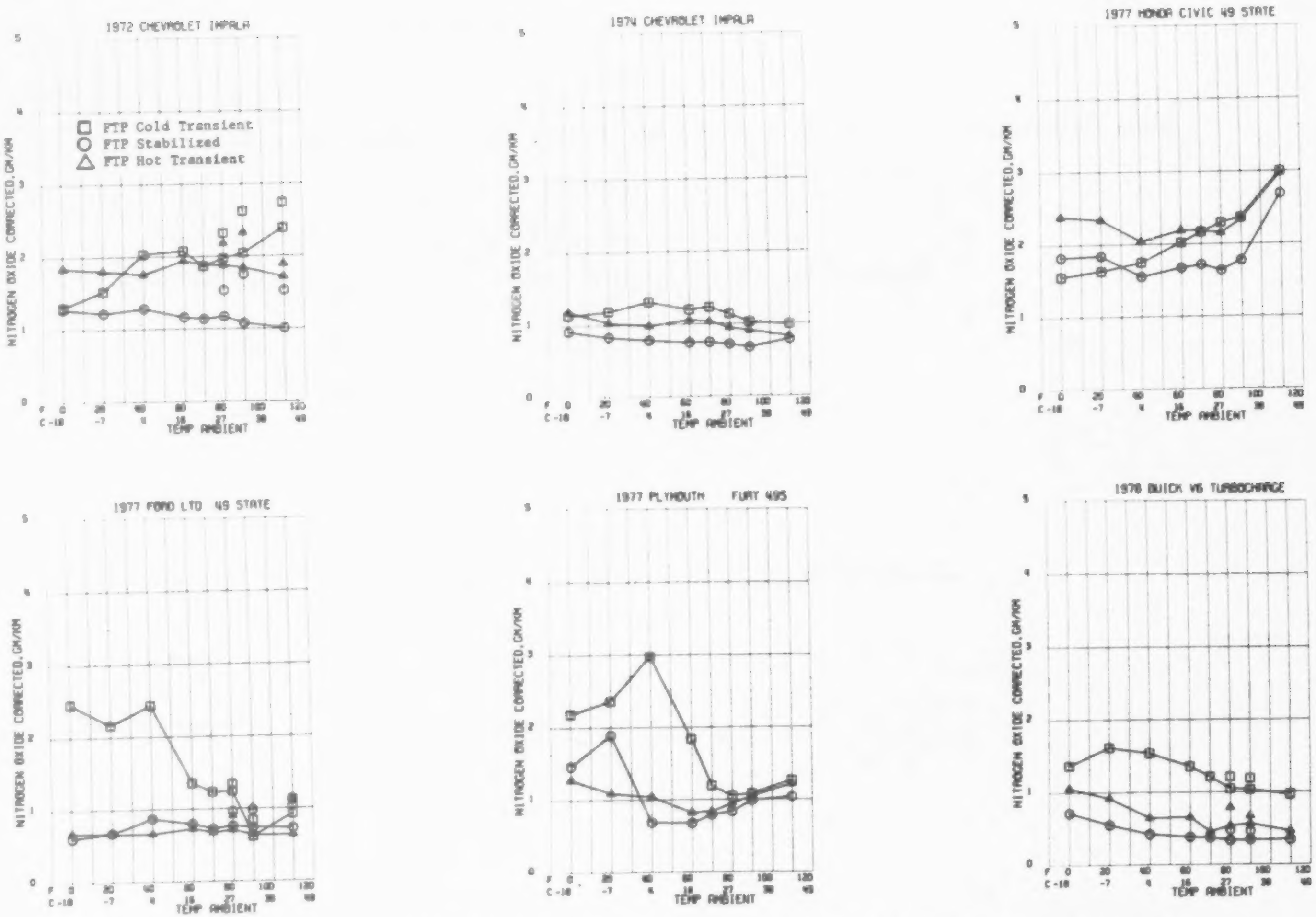
(Data points not connected by a line are the results of air conditioning runs.)

Figure 9. Effect of ambient temperature on uncorrected nitrogen oxide emissions for the test cycles.



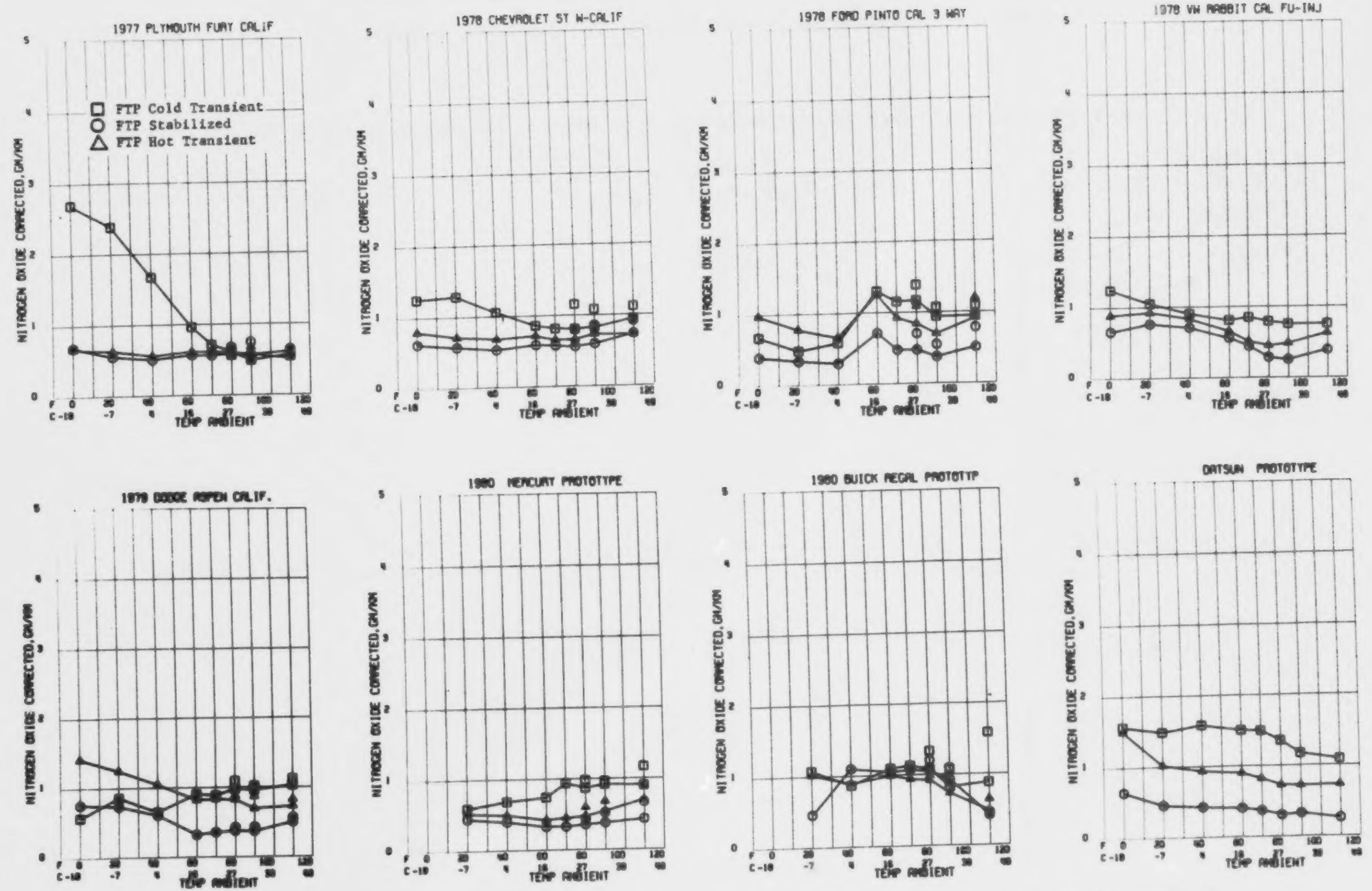
(Data points not connected by a line are the results of air conditioning runs.)

Figure 9. (continued)



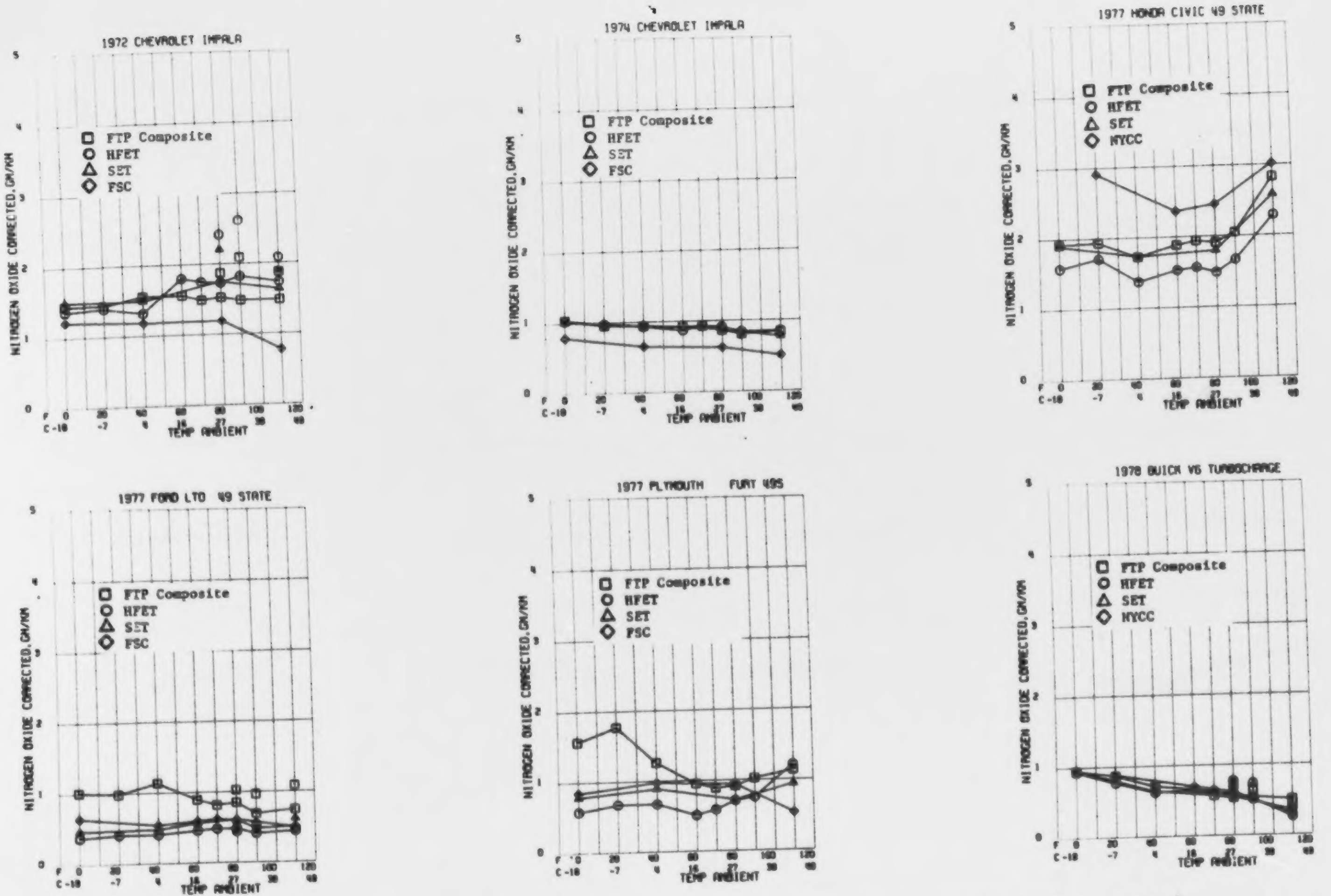
(Data points not connected by a line are the results of air conditioning runs.)

Figure 10. Effect of ambient temperature on corrected nitrogen oxide emissions for the FTP.



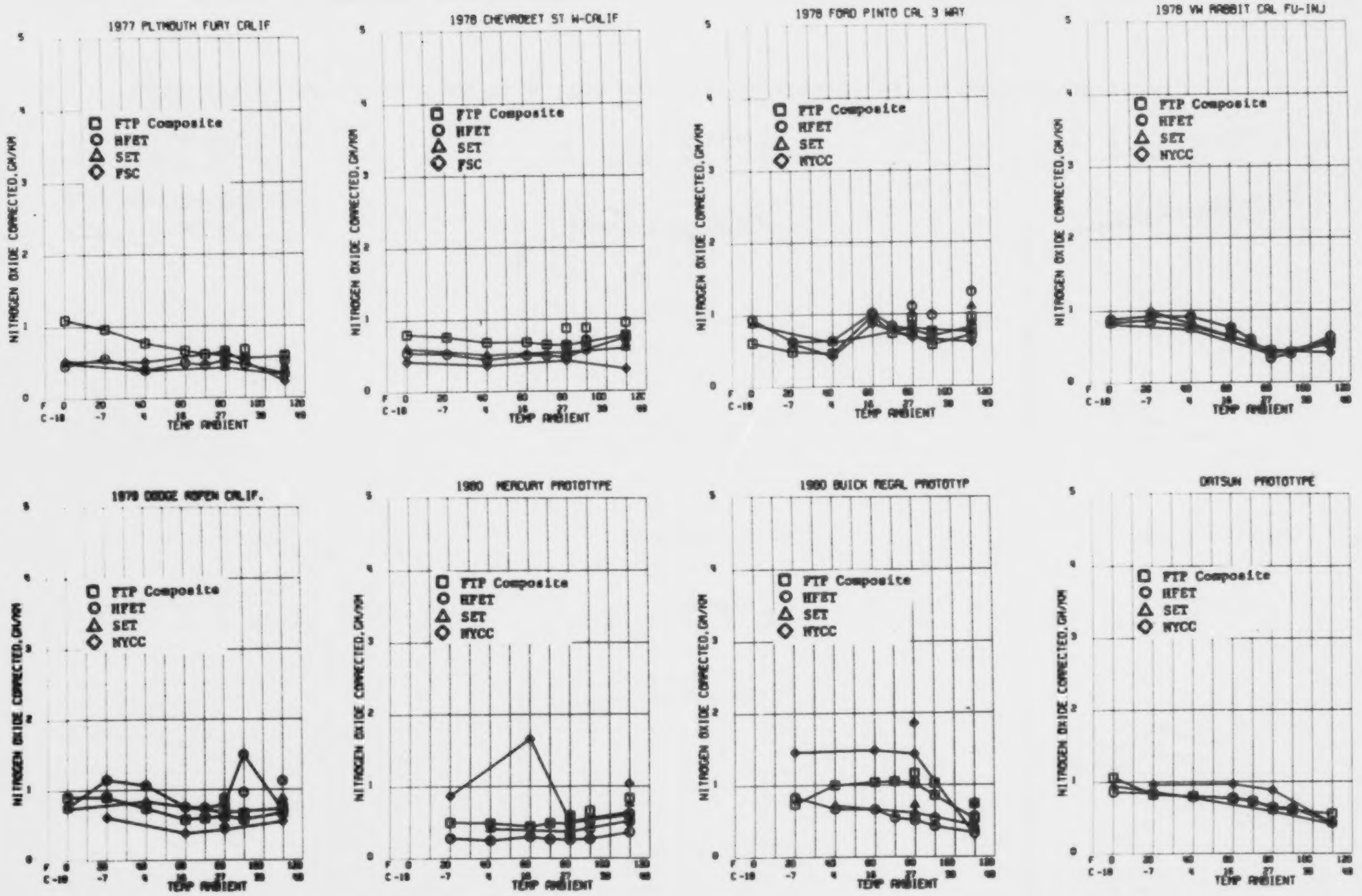
(Data points not connected by a line are the results of air conditioning runs.)

Figure 10. (continued)



(Data points not connected by a line are the results of air conditioning runs.)

Figure 11. Effect of ambient temperature on corrected nitrogen oxide emissions for the test cycles.



(Data points not connected by a line are the results of air conditioning runs.)

Figure 11. (continued)

transient phase of the FTP. The total range of average values obtained by all of the cars at all of the temperatures was from 0.33 g/km for 1977 California Plymouth to 3.74 g/km for the 1977 49-State Plymouth. NOX emissions generally decreased at constant relative humidity as the temperature increased above 40°F (4°C). This is believed to be due, in part, to the higher absolute humidity at the higher temperatures. In almost every case, NOX emissions increased when the air conditioners were on. This result was probably due to increased engine load.

Table 45 compares the average NOX emissions with the average NOX corrected (NOXC) emissions. These results show that the correction decreased NOX at temperatures below 70°F (21°C) and increased them at temperatures above 80°F (27°C) indicating that the current humidity correction should not be applied at temperatures outside the normal FTP range.

TABLE 45 FTP COLD TRANSIENT AVERAGE NOX & NOXC - G/KM

TEMPERATURE F (C)		0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA												
	NOX AVE	1.73	2.01	2.58	2.41	2.02	1.94	2.30	1.78	2.26	1.22	1.81
	NOXC AVE	1.80	1.52	2.03	2.07	1.86	1.97	2.32	2.04	2.62	2.39	2.74
1976 CHEVROLET IMPALA												
	NOX AVE	1.49	1.56	1.67	1.40	1.33	1.08	.	0.87	.	0.52	.
	NOXC AVE	1.13	1.18	1.30	1.20	1.23	1.13	.	1.02	.	0.98	.
1977 HONDA CIVIC 49 STATE												
	NOX AVE	2.06	2.15	2.21	2.36	2.35	2.29	.	2.02	.	1.90	.
	NOXC AVE	1.55	1.63	1.74	2.02	2.16	2.29	.	2.36	.	3.00	.
1977 FORD LTD 49 STATE												
	NOX AVE	3.26	2.82	3.05	1.58	1.34	1.18	1.28	0.52	0.69	0.49	0.59
	NOXC AVE	2.45	2.16	2.43	1.35	1.23	1.24	1.34	0.61	0.84	0.92	1.12
1977 PLYMOUTH FURY 49S												
	NOX AVE	2.90	3.10	3.74	2.12	1.29	1.03	.	0.92	.	0.76	.
	NOXC AVE	2.19	2.36	2.98	1.83	1.19	1.05	.	1.08	.	1.26	.
1978 BUICK V6 TURBOCHARGE												
	NOX AVE	1.82	2.13	1.91	1.58	1.31	1.01	1.17	0.88	1.01	0.57	0.56
	NOXC AVE	1.36	1.61	1.53	1.35	1.21	1.04	1.21	1.03	1.18	0.96	0.97
1977 PLYMOUTH FURY CALIF												
	NOX AVE	3.56	3.16	2.10	1.11	0.77	0.58	0.54	0.44	0.42	0.36	0.33
	NOXC AVE	2.69	2.38	1.67	0.95	0.71	0.60	0.56	0.52	0.52	0.56	0.55
1978 CHEVROLET ST W-CALIF												
	NOX AVE	1.65	1.68	1.33	1.00	0.89	0.79	1.13	0.70	0.92	0.52	0.67
	NOXC AVE	1.25	1.28	1.06	0.86	0.91	0.80	1.15	0.82	1.08	0.94	1.12
1978 FORD PINTO CAL 3 WAY												
	NOX AVE	0.89	0.63	0.74	1.52	1.25	1.15	1.34	0.53	0.93	0.53	0.68
	NOXC AVE	0.67	0.48	0.58	1.10	1.15	1.17	1.38	0.62	1.07	0.94	1.09
1978 VW RABBIT CAL FU-INJ												
	NOX AVE	1.65	1.38	1.15	0.94	0.91	0.78	.	0.65	.	0.44	.
	NOXC AVE	1.24	1.04	0.90	0.80	0.85	0.79	.	0.75	.	0.78	.
1979 DODGE ASPEN CALIF.												
	NOX AVE	0.75	1.13	0.86	1.03	0.97	0.96	1.07	0.82	0.86	0.47	0.52
	NOXC AVE	0.56	0.85	0.65	0.90	0.88	0.97	1.09	0.96	1.02	1.02	1.12
1980 MERCURY PROTOTYPE												
	NOX AVE	.	0.77	0.87	0.86	1.01	0.85	0.96	0.87	0.81	0.58	0.69
	NOXC AVE	.	0.59	0.69	0.74	0.93	0.87	0.98	0.92	0.96	0.90	1.17
1980 BUICK REGAL PROTOTYP												
	NOX AVE	.	1.41	1.09	1.27	1.23	1.05	1.32	0.73	0.96	0.44	0.80
	NOXC AVE	.	1.07	0.86	1.09	1.13	1.07	1.33	0.82	1.07	0.88	1.58
DATSUN PROTOTYPE												
	NOX AVE	2.07	1.94	1.99	1.74	1.61	1.31	.	1.01	.	0.61	.
	NOXC AVE	1.56	1.48	1.58	1.50	1.49	1.35	.	1.17	.	1.08	.

Federal Test Procedure-Stabilized-NOX--

Table 46 gives the NOX emissions for the stabilized phase of the FTP. This condition, which lead to the lowest CO and hydrocarbon emissions also produced the lowest NOX emissions. The total range of average NOX emissions was from 0.14 for the Datsun at 110°F (43°C) to 2.49 for the 1977 (49 State) Plymouth at 20°F (-7°C).

TABLE 46 F T P STABILIZED - NITROGEN OXIDES G/KM

TEMPERATURE F (C)		0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA		1.73	1.53	1.69	1.17	1.29	1.20	1.55	0.94	1.56	0.57	0.85
		1.66	1.69	1.57	1.33	1.17	1.09	1.46	0.90	1.44	0.46	0.84
	AVE	1.70	1.61	1.63	1.25	1.23	1.15	1.51	0.92	1.50	0.51	0.84
1976 CHEVROLET IMPALA		1.24	1.11	1.01	0.87	0.81	0.70	*	0.61	*	0.41	*
		1.17	1.07	0.97	0.89	0.81	0.67	*	0.54	*	0.41	*
		*	*	*	0.83	*	*	*	*	*	*	*
	AVE	1.21	1.09	0.99	0.86	0.81	0.68	*	0.58	*	0.41	*
1977 HONDA CIVIC 49 STATE		2.37	2.70	1.95	1.85	1.78	1.60	*	1.61	*	1.80	*
		2.45	2.15	1.98	2.06	1.95	1.68	*	1.42	*	1.62	*
	AVE	2.41	2.42	1.96	1.95	1.86	1.64	*	1.52	*	1.71	*
1977 FORD LTD 49 STATE		0.76	0.88	1.27	0.90	0.80	0.74	0.90	0.60	0.71	0.40	0.55
		0.83	0.90	0.92	0.96	0.78	0.71	0.94	0.66	0.89	0.38	0.54
		0.85	*	*	*	*	*	*	*	*	*	*
	AVE	0.81	0.89	1.09	0.93	0.79	0.72	0.92	0.63	0.80	0.39	0.54
1977 PLYMOUTH FURY 49S		2.33	3.42	0.65	0.55	0.84	0.82	*	0.84	*	0.61	*
		1.56	1.57	1.07	0.89	0.89	0.83	*	0.85	*	0.63	*
		*	*	*	0.87	0.86	*	*	*	*	*	*
	AVE	1.95	2.49	0.86	0.77	0.86	0.82	*	0.84	*	0.62	*
1978 BUICK V6 TURBOCHARGE		0.91	0.83	0.59	0.43	0.42	0.33	0.43	0.26	0.38	0.14	0.17
		1.02	0.62	0.45	0.45	0.38	0.31	0.49	0.31	0.40	0.27	0.21
		0.93	*	*	*	*	*	*	*	*	*	*
	AVE	0.95	0.72	0.52	0.44	0.40	0.32	0.46	0.29	0.39	0.21	0.19
1977 PLYMOUTH FURY CALIF		0.92	0.73	0.69	0.67	0.55	0.58	0.59	0.48	0.61	0.40	0.48
		0.88	0.73	0.59	0.65	0.65	0.54	0.73	0.48	0.59	0.37	0.27
		*	*	*	*	*	*	*	*	*	*	0.41
	AVE	0.90	0.73	0.64	0.66	0.60	0.56	0.66	0.48	0.60	0.38	0.39
1978 CHEVROLET ST W-CALIF		0.85	0.73	0.68	0.68	0.61	0.52	0.79	0.51	0.68	0.39	0.53
		0.79	0.76	0.65	0.69	0.64	0.57	0.78	0.50	0.78	0.42	0.57
	AVE	0.82	0.74	0.67	0.68	0.62	0.55	0.78	0.50	0.73	0.40	0.55
1978 FORD PINTO CAL 3 WAY		0.67	0.60	0.47	0.76	0.58	0.50	0.73	*	0.52	0.26	0.41
		0.43	0.28	0.27	0.91	0.45	0.42	0.63	0.29	0.42	0.31	0.53
		0.48	*	*	*	*	*	*	0.34	*	*	0.53
	AVE	0.53	0.44	0.37	0.83	0.52	0.46	0.68	0.32	0.47	0.29	0.49
1978 VW RABBIT CAL FU-INJ		0.97	1.01	0.82	0.59	0.56	0.31	*	0.25	*	0.24	*
		0.77	1.00	0.98	0.71	0.42	0.25	*	0.18	*	0.22	*
	AVE	0.87	1.01	0.90	0.65	0.49	0.28	*	0.21	*	0.23	*
1979 DODGE ASPEN CALIF.		1.15	0.69	0.49	0.34	0.38	0.36	0.42	0.30	0.40	0.23	0.25
		0.85	1.23	1.11	0.39	0.39	0.38	0.41	0.33	0.32	0.23	0.27
	AVE	1.00	0.96	0.80	0.36	0.39	0.37	0.41	0.31	0.36	0.23	0.26
1980 MERCURY PROTOTYPE		*	0.57	0.50	0.38	0.37	0.32	0.43	0.36	0.44	0.29	0.38
		*	0.59	*	*	0.34	0.37	*	*	*	0.24	0.40
	AVE	*	0.58	0.50	0.38	0.35	0.34	0.43	0.36	0.44	0.26	0.39
1980 BUICK REGAL PROTOTYP		*	0.05	1.39	1.21	1.12	1.04	1.19	0.83	0.98	0.21	0.23
		*	1.15	*	*	1.21	1.00	*	*	*	0.21	0.23
	AVE	*	0.60	1.39	1.21	1.16	1.02	1.19	0.83	0.98	0.21	0.23
DATSUN PROTOTYPE		0.93	0.57	0.54	0.50	0.40	0.29	*	0.27	*	0.13	*
		0.77	0.62	0.52	0.43	0.40	0.29	*	0.29	*	0.15	*
		*	*	0.54	*	*	*	*	*	*	*	*
	AVE	0.85	0.60	0.53	0.47	0.40	0.29	*	0.28	*	0.14	*

Table 47 compares the average measured NOX and the average corrected NOX data. These results show that at 110°F (43°C) the corrected NOX is much higher than the measured NOX while at 0°F (-18°C) corrected NOX is appreciably lower.

TABLE 47 FTP STABILIZED AVERAGE NOX & NOXC - G/KM

TEMPERATURE F	0	20	40	60	70	80	80AC	90	90AC	110	110AC
(C)	(-18)	(-7)	(4)	(16)	(21)	(27)	(27)	(32)	(32)	(43)	(43)
1972 CHEVROLET IMPALA											
NOX AVE	1.70	1.61	1.62	1.35	1.24	1.15	1.51	0.92	1.50	0.51	0.84
NOXC AVE	1.28	1.22	1.29	1.16	1.13	1.16	1.53	1.07	1.75	1.08	1.52
1974 CHEVROLET IMPALA											
NOX AVE	1.21	1.09	0.99	0.86	0.81	0.68	*	0.58	*	0.41	*
NOXC AVE	0.91	0.83	0.78	0.74	0.75	0.71	*	0.67	*	0.78	*
1977 HONDA CIVIC 49 STATE											
NOX AVE	2.41	2.42	1.96	1.95	1.86	1.84	*	1.52	*	1.71	*
NOXC AVE	1.82	1.84	1.55	1.67	1.71	1.63	*	1.77	*	2.69	*
1977 FORD LTD 49 STATE											
NOX AVE	0.81	0.89	1.09	0.93	0.79	0.72	0.92	0.63	0.80	0.39	0.54
NOXC AVE	0.61	0.68	0.87	0.79	0.72	0.76	0.96	0.74	0.98	0.73	1.03
1977 PLYMOUTH FURY 49S											
NOX AVE	1.95	2.49	0.86	0.77	0.86	0.82	*	0.84	*	0.62	*
NOXC AVE	1.46	1.89	0.69	0.67	0.79	0.84	*	0.98	*	1.03	*
1978 BUICK V6 TURBOCHARGE											
NOX AVE	0.95	0.72	0.52	0.44	0.40	0.32	0.46	0.29	0.39	0.21	0.19
NOXC AVE	0.71	0.55	0.42	0.16	0.17	0.33	0.47	0.34	0.46	0.34	0.33
1977 PLYMOUTH FURY CALIF											
NOX AVE	0.90	0.73	0.64	0.66	0.60	0.56	0.66	0.48	0.60	0.38	0.39
NOXC AVE	0.68	0.55	0.51	0.57	0.56	0.58	0.67	0.56	0.74	0.61	0.64
1978 CHEVROLET ST W-CALIF											
NOX AVE	0.82	0.74	0.67	0.68	0.62	0.55	0.78	0.50	0.73	0.40	0.55
NOXC AVE	0.62	0.57	0.53	0.59	0.57	0.56	0.80	0.59	0.86	0.73	0.91
1978 FORD PINTO CAL 3 WAY											
NOX AVE	0.53	0.44	0.37	0.83	0.52	0.46	0.68	0.21	0.47	0.29	0.49
NOXC AVE	0.40	0.34	0.30	0.7.	0.47	0.47	0.70	0.25	0.54	0.50	0.78
1978 VW RABBIT CAL FU-INJ											
NOX AVE	0.87	1.01	0.90	0.65	0.49	0.28	*	0.21	*	0.23	*
NOXC AVE	0.65	0.76	0.70	0.56	0.44	0.28	*	0.25	*	0.39	*
1979 DODGE ASPEN CALIF.											
NOX AVE	1.00	0.96	0.80	0.36	0.39	0.37	0.41	0.31	0.36	0.23	0.26
NOXC AVE	0.75	0.73	0.61	0.32	0.35	0.37	0.42	0.37	0.42	0.50	0.56
1980 MERCURY PROTOTYPE											
NOX AVE	*	0.58	0.50	0.38	0.35	0.34	0.43	0.36	0.44	0.26	0.39
NOXC AVE	*	0.44	0.43	0.33	0.33	0.35	0.44	0.38	0.52	0.43	0.67
1980 BUICK REGAL PROTOTYP											
NOX AVE	*	0.60	1.39	1.21	1.16	1.02	1.19	0.83	0.98	0.21	0.23
NOXC AVE	*	0.46	1.10	1.04	1.07	1.04	1.20	0.92	1.09	0.42	0.46
DATSUN PROTOTYPE											
NOX AVE	0.85	0.60	0.53	0.47	0.40	0.29	*	0.28	*	0.14	*
NOXC AVE	0.64	0.46	0.42	0.40	0.37	0.30	*	0.32	*	0.25	*

Federal Test Procedure-Hot Transient-NOX--

Table 48 lists the NOX emissions for the hot transient phase of the FTP. These emissions were much like those of the cold transient phase with a range of average values from 0.22 g/km for the 1978 Buick at 110°F (43°C) with AC to 3.16 g/km for the 1977 Honda at 0°F (-18°C). As before, the use of the air conditioners generally resulted in increased NOX emissions.

TABLE 48 F.T.P. HOT TRANSIENT - NITROGEN OXIDES G/KM

TEMPERATURE F	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	2.46	2.20	2.28	2.45	2.34	2.12	2.19	1.82	2.10	1.07	1.04
	2.43	2.56	2.17	2.07	1.75	1.58	2.13	1.34	1.89	0.69	1.05
AVE	2.45	2.38	2.23	2.26	2.05	1.85	2.16	1.58	1.99	0.88	1.04
1974 CHEVROLET IMPALA	1.59	1.25	1.47	1.15	1.16	0.95	.	0.77	.	0.40	.
	1.55	1.45	1.03	1.27	1.08	0.85	.	0.78	.	0.46	.
	.	.	.	1.28	.	.	.	.	.	.	.
AVE	1.57	1.35	1.25	1.23	1.12	0.90	.	0.77	.	0.43	.
1977 HONDA CIVIC 49 STATE	3.25	3.15	2.62	2.55	2.35	2.18	.	2.04	.	1.94	.
	3.08	3.01	2.54	2.57	2.40	2.12	.	1.96	.	1.84	.
AVE	3.16	3.08	2.58	2.56	2.37	2.15	.	2.00	.	1.89	.
1977 FORD LTD 49 STATE	0.87	0.86	0.84	0.89	0.77	0.73	0.84	0.53	0.76	0.31	0.60
	0.93	0.87	0.82	0.81	0.70	0.61	0.88	0.55	0.89	0.36	0.61
	0.91	.	.	.	.	.	.	.	.	.	.
AVE	0.90	0.87	0.83	0.85	0.73	0.67	0.86	0.54	0.82	0.34	0.61
1977 PLYMOUTH FURY 49S	1.77	1.47	1.15	0.93	0.90	0.93	.	0.94	.	0.72	.
	1.63	1.39	1.45	0.98	0.91	0.93	.	0.85	.	0.73	.
	.	.	.	0.91	0.90	.	.	.	.	.	.
AVE	1.70	1.43	1.30	0.94	0.90	0.93	.	0.90	.	0.73	.
1978 BUICK V6 TURBOCHARGE	1.39	1.30	0.95	0.73	0.69	0.55	0.80	0.43	0.55	0.15	0.17
	1.40	1.11	0.66	0.80	0.30	0.49	0.72	0.54	0.58	0.40	0.26
	1.43	.	.	.	.	.	.	.	.	.	.
AVE	1.41	1.21	0.80	0.76	0.49	0.52	0.76	0.48	0.57	0.27	0.22
1977 PLYMOUTH FURY CALIF	0.88	0.74	0.76	0.73	0.66	0.56	0.59	0.49	0.53	0.35	0.38
	0.87	0.93	0.65	0.69	0.67	0.59	0.71	0.48	0.56	0.30	0.25
	.	.	.	.	.	.	.	.	.	.	0.30
AVE	0.87	0.83	0.71	0.71	0.67	0.57	0.65	0.48	0.54	0.33	0.31
1976 CHEVROLET ST W-CALIF	1.06	0.90	0.88	0.79	0.69	0.64	0.78	0.59	0.61	0.37	0.60
	1.03	0.96	0.83	0.87	0.74	0.66	0.82	0.64	0.66	0.42	0.49
AVE	1.05	0.93	0.86	0.83	0.72	0.65	0.80	0.61	0.64	0.40	0.55
1976 FORD PINTO CAL 3 WAY	1.38	1.03	0.98	1.54	1.09	0.87	1.01	.	0.87	0.41	0.62
	1.18	1.01	0.68	1.40	0.92	0.76	1.09	0.55	0.80	0.62	0.92
	1.32	.	.	.	.	.	.	0.64	.	.	0.70
AVE	1.29	1.02	0.83	1.47	1.01	0.82	1.05	0.59	0.83	0.52	0.75
1976 VW RABBIT CAL FU-INJ	1.29	1.16	0.93	0.74	0.54	0.43	.	0.41	.	0.40	.
	1.06	1.28	1.18	0.78	0.57	0.46	.	0.42	.	0.33	.
AVE	1.18	1.22	1.06	0.76	0.55	0.44	.	0.41	.	0.37	.
1979 DODGE ASPEN CALIF.	1.90	1.59	1.24	0.83	0.90	0.74	0.81	0.56	0.76	0.33	0.35
	1.85	1.70	1.52	1.04	0.92	0.88	0.91	0.63	0.72	0.33	0.41
AVE	1.87	1.64	1.38	0.94	0.91	0.81	0.86	0.59	0.74	0.33	0.38
1980 MERCURY PROTOTYPE	.	0.72	0.63	0.49	0.49	0.46	0.59	0.51	0.58	0.44	0.51
	.	0.65	.	.	0.48	0.46	.	.	.	0.41	0.55
AVE	.	0.68	0.63	0.49	0.49	0.46	0.59	0.51	0.58	0.43	0.53
1980 BUICK REGAL PROTOTYP	.	1.42	1.13	1.16	1.04	0.84	0.97	0.66	0.77	0.23	0.31
	.	1.25	.	.	1.02	0.95	.	.	.	0.25	0.34
AVE	.	1.33	1.13	1.16	1.03	0.90	0.97	0.66	0.77	0.24	0.33
DATSUN PROTOTYPE	2.06	1.34	1.18	1.05	0.88	0.75	.	0.62	.	0.45	.
	1.91	1.32	1.11	1.04	0.89	0.67	.	0.61	.	0.36	.
	.	.	1.25	.	.	.	.	.	.	.	.
AVE	1.98	1.33	1.18	1.04	0.89	0.71	.	0.62	.	0.41	.

Table 49 compares the average NOX with the average corrected NOX (NOXC). The same decreases in NOX at low temperatures and increases in NOX at high temperatures as a result of the correction were again noted.

TABLE 49 FTP HOT TRANSIENT AVERAGE NOX & NOXC - G/KM

	TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA												
	NOX AVE	2.45	2.38	2.23	2.26	2.05	1.85	2.16	1.58	1.99	0.88	1.04
	NOXC AVE	1.84	1.80	1.75	1.94	1.89	1.87	2.18	1.84	2.32	1.71	1.89
1974 CHEVROLET IMPALA												
	NOX AVE	1.57	1.35	1.25	1.23	1.12	0.90	.	0.77	.	0.43	.
	NOXC AVE	1.19	1.02	0.98	1.05	1.03	0.94	.	0.90	.	0.82	.
1977 HONDA CIVIC 49 STATE												
	NOX AVE	3.16	3.08	2.58	2.56	2.37	2.15	.	2.00	.	1.89	.
	NOXC AVE	2.38	2.34	2.03	2.18	2.18	2.15	.	2.33	.	2.97	.
1977 FORD LTD 49 STATE												
	NOX AVE	0.90	0.87	0.81	0.85	0.73	0.67	0.66	0.54	0.82	0.34	0.61
	NOXC AVE	0.68	0.66	0.66	0.71	0.67	0.71	0.90	0.63	1.01	0.63	1.15
1977 PLYMOUTH FURY 49S												
	NOX AVE	1.70	1.43	1.30	0.94	0.90	0.93	.	0.98	.	0.73	.
	NOXC AVE	1.28	1.09	1.04	0.82	0.83	0.94	.	1.04	.	1.21	.
1978 BUICK V6 TURBOCHARGE												
	NOX AVE	1.41	1.21	0.80	0.76	0.44	0.52	0.76	0.48	0.57	0.27	0.22
	NOXC AVE	1.05	0.91	0.64	0.65	0.45	0.53	0.78	0.56	0.67	0.46	0.38
1977 PLYMOUTH FURY CALIF												
	NOX AVE	0.87	0.83	0.71	0.71	0.67	0.57	0.65	0.49	0.54	0.33	0.31
	NOXC AVE	0.66	0.63	0.58	0.61	0.61	0.59	0.67	0.58	0.67	0.51	0.52
1978 CHEVROLET ST W-CALIF												
	NOX AVE	1.05	0.93	0.86	0.83	0.72	0.65	0.80	0.61	0.64	0.40	0.55
	NOXC AVE	0.79	0.71	0.68	0.71	0.65	0.66	0.82	0.73	0.75	0.72	0.91
1978 FORD PINTO CAL 3 WAY												
	NOX AVE	1.29	1.02	0.83	1.47	1.01	0.82	1.05	0.39	0.83	0.52	0.75
	NOXC AVE	0.97	0.78	0.66	1.25	0.92	0.83	1.08	0.46	0.96	0.91	1.18
1978 VW RABBIT CAL FU-INJ												
	NOX AVE	1.18	1.22	1.06	0.76	0.55	0.44	.	0.41	.	0.37	.
	NOXC AVE	0.89	0.92	0.83	0.65	0.51	0.45	.	0.48	.	0.62	.
1979 DODGE ASPEN CALIF.												
	NOX AVE	1.87	1.64	1.38	0.94	0.91	0.81	0.86	0.59	0.74	0.33	0.38
	NOXC AVE	1.41	1.24	1.04	0.82	0.83	0.82	0.87	0.69	0.87	0.72	0.82
1980 MERCURY PROTOTYPE												
	NOX AVE	.	0.68	0.63	0.49	0.49	0.46	0.59	0.51	0.58	0.43	0.53
	NOXC AVE	.	0.52	0.50	0.42	0.45	0.47	0.60	0.54	0.68	0.69	0.90
1980 BUICK REGAL PROTOTYP												
	NOX AVE	.	1.33	1.13	1.16	1.03	0.90	0.97	0.66	0.77	0.24	0.33
	NOXC AVE	.	1.02	0.89	0.99	0.94	0.92	0.97	0.73	0.86	0.48	0.64
DATSUN PROTOTYPE												
	NOX AVE	1.98	1.33	1.18	1.04	0.89	0.71	.	0.62	.	0.41	.
	NOXC AVE	1.50	1.01	0.93	0.90	0.82	0.72	.	0.71	.	0.72	.

Federal Test Procedure-Composite-NOX--

Table 50 lists the composite NOX data from all three phases of the FTP. It should be noted that all of the vehicles, except the Honda, met the appropriate standard, as given in Table 15, when evaluated at 70 or 80°F (21 or 27°C) which are the only temperatures that meet the specified temperature range for this procedure.

The composite results showed the same trends as the individual phases. Some vehicle technologies produced lower NOX emissions than others. All of the vehicles produced the lowest NOX emissions at 110°F (43°C) and all of those tested with their air conditioners on generally gave increased NOX emissions.

TABLE 50 F T P COMPOSITE - NITROGEN OXIDES G/KM

TEMPERATURE F (C)		0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA		1.94	1.78	1.49	1.86	1.76	1.64	1.92	1.40	1.90	0.86	1.06
		1.88	2.02	1.48	1.76	1.47	1.35	1.77	1.15	1.68	0.65	1.01
	AVE	1.91	1.90	1.48	1.81	1.61	1.50	1.85	1.27	1.79	0.76	1.03
1976 CHEVROLET IMPALA		1.32	1.21	1.34	1.04	1.02	0.85	*	0.71	*	0.46	*
		1.41	1.30	1.07	1.12	0.98	0.80	*	0.67	*	0.42	*
		*	*	*	1.07	*	*	*	*	*	*	*
	AVE	1.36	1.26	1.20	1.07	1.00	0.82	*	0.69	*	0.44	*
1977 HONDA CIVIC 49 STATE		2.57	2.66	2.30	2.13	2.03	1.89	*	1.81	*	1.87	*
		2.51	2.44	2.06	2.28	2.17	1.93	*	1.69	*	1.73	*
	AVE	2.54	2.54	2.18	2.20	2.10	1.91	*	1.75	*	1.80	*
1977 FORD LTD 49 STATE		1.21	1.30	1.52	1.04	0.88	0.84	0.97	0.56	0.72	0.40	0.58
		1.42	1.26	1.32	1.03	0.89	0.77	0.99	0.60	0.84	0.39	0.56
		1.39	*	*	*	*	*	*	*	*	*	*
	AVE	1.34	1.28	1.42	1.04	0.89	0.80	0.98	0.58	0.78	0.39	0.57
1977 PLYMOUTH FURY 49S		2.60	2.87	1.15	1.18	0.93	0.87	*	0.87	*	0.67	*
		1.90	1.79	2.01	1.09	0.97	0.92	*	0.87	*	0.68	*
		*	*	*	1.02	0.99	*	*	*	*	*	*
	AVE	2.25	2.33	1.58	1.10	0.96	0.90	*	0.87	*	0.68	*
1978 BUICK V6 TURBOCHARGE		1.24	1.19	0.97	0.74	0.67	0.53	0.68	0.42	0.55	0.23	0.23
		1.31	1.09	0.80	0.78	0.56	0.50	0.70	0.51	0.58	0.37	0.32
		1.21	*	*	*	*	*	*	*	*	*	*
	AVE	1.25	1.14	0.88	0.76	0.61	0.52	0.69	0.46	0.56	0.30	0.27
1977 PLYMOUTH FURY CALIF		1.46	1.21	1.03	0.80	0.64	0.58	0.57	0.47	0.55	0.37	0.42
		1.43	1.32	0.89	0.73	0.67	0.56	0.68	0.46	0.54	0.35	0.26
		*	*	*	*	*	*	*	*	*	*	0.37
	AVE	1.45	1.26	0.96	0.76	0.66	0.57	0.63	0.46	0.55	0.36	0.35
1978 CHEVROLET ST W-CALIF		1.05	1.01	0.90	0.77	0.68	0.61	0.87	0.57	0.69	0.41	0.58
		1.06	0.97	0.81	0.80	0.73	0.64	0.85	0.57	0.79	0.44	0.57
	AVE	1.05	0.99	0.85	0.79	0.70	0.63	0.86	0.57	0.74	0.43	0.57
1978 FORD PINTO CAL 3 WAY		0.88	0.72	0.68	1.12	0.85	0.74	0.93	*	0.70	0.34	0.51
		0.72	0.55	0.46	1.17	0.75	0.66	0.90	0.46	0.62	0.46	0.65
		0.82	*	*	*	*	*	*	0.51	*	*	0.63
	AVE	0.81	0.64	0.57	1.14	0.80	0.70	0.91	0.49	0.66	0.40	0.60
1978 VW RABBIT CAL FU-INJ		1.20	1.11	0.91	0.69	0.63	0.45	*	0.38	*	0.33	*
		1.03	1.17	1.07	0.79	0.56	0.40	*	0.33	*	0.29	*
	AVE	1.11	1.14	0.99	0.74	0.59	0.42	*	0.36	*	0.31	*
1979 DODGE ASPEN CALIF.		1.27	0.95	0.78	0.60	0.61	0.56	0.65	0.45	0.57	0.29	0.33
		1.10	1.41	1.15	0.71	0.68	0.65	0.69	0.53	0.56	0.32	0.38
	AVE	1.18	1.18	0.97	0.66	0.65	0.61	0.67	0.49	0.57	0.31	0.36
1980 MERCURY PROTOTYPE		*	0.66	0.61	0.51	0.52	0.46	0.50	0.50	0.55	0.39	0.48
		*	0.65	*	*	0.53	0.50	*	*	*	0.34	0.50
	AVE	*	0.65	0.61	0.51	0.52	0.48	0.50	0.50	0.55	0.37	0.49
1980 BUICK REGAL PROTOTYPE		*	0.67	1.26	1.21	1.11	0.99	1.15	0.76	0.82	0.28	0.36
		*	1.26	*	*	1.17	1.00	*	*	*	0.25	0.38
	AVE	*	0.97	1.26	1.21	1.14	0.99	1.15	0.76	0.82	0.26	0.37
DATSUN PROTOTYPE		1.45	1.03	0.99	0.90	0.78	0.63	*	0.52	*	0.33	*
		1.36	1.10	1.01	0.86	0.78	0.60	*	0.52	*	0.28	*
		*	*	1.03	*	*	*	*	*	*	*	*
	AVE	1.40	1.07	1.01	0.88	0.78	0.61	*	0.52	*	0.31	*

Table 51 compares the measured average NOX with the corrected average NOXC. As before, the correction reduced NOX at the lower temperatures but increased them at the higher temperatures.

TABLE 51 FTP COMPOSITE AVERAGE NOX & NOXC - G/KM

TEMPERATURE F		0 (C)(-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA												
	NOX AVE	1.93	1.90	1.98	1.81	1.61	1.50	1.85	1.27	1.79	0.76	1.03
	NOXC AVE	1.44	1.44	1.56	1.56	1.49	1.52	1.67	1.46	2.06	1.46	1.87
1974 CHEVROLET IMPALA												
	NOX AVE	1.36	1.26	1.20	1.07	1.06	0.82	-	0.69	-	0.44	-
	NOXC AVE	1.03	0.95	0.94	0.92	0.92	0.86	-	0.61	-	0.81	-
1977 HONDA CIVIC 49 STATE												
	NOX AVE	2.54	2.58	2.18	2.20	2.10	1.91	-	1.75	-	1.80	-
	NOXC AVE	1.91	1.93	1.72	1.88	1.91	1.91	-	2.08	-	2.81	-
1977 FORD LTD 49 STATE												
	NOX AVE	1.34	1.28	1.42	1.09	0.89	0.80	0.58	0.58	0.76	0.39	0.57
	NOXC AVE	1.01	0.98	1.13	0.89	0.81	0.84	1.02	0.76	0.96	0.74	1.08
1977 PLYMOUTH FURY 400												
	NOX AVE	2.09	2.11	1.50	1.10	0.96	0.90	-	0.67	-	0.68	-
	NOXC AVE	1.54	1.77	1.26	0.85	0.89	0.91	-	1.02	-	1.13	-
1978 BUICK V6 TURBOCHARGE												
	NOX AVE	1.25	1.14	0.88	0.76	0.51	0.52	0.69	0.46	0.56	0.30	0.27
	NOXC AVE	0.94	0.87	0.71	0.65	0.56	0.53	0.71	0.54	0.66	0.50	0.47
1977 PLYMOUTH FURY CALIF												
	NOX AVE	1.65	1.20	0.96	0.76	0.65	0.57	0.63	0.47	0.55	0.36	0.35
	NOXC AVE	1.09	0.95	0.76	0.66	0.60	0.59	0.65	0.56	0.67	0.57	0.59
1978 CHEVROLET ST W-CALIF												
	NOX AVE	1.05	0.99	0.85	0.79	0.70	0.61	0.86	0.57	0.78	0.41	0.57
	NOXC AVE	0.79	0.76	0.68	0.68	0.64	0.61	0.87	0.68	0.87	0.77	0.95
1978 FORD PINTO CAL 3 WAY												
	NOX AVE	0.81	0.64	0.57	1.14	0.80	0.70	0.41	0.11	0.60	0.40	0.60
	NOXC AVE	0.61	0.48	0.45	0.58	0.71	0.71	0.58	0.18	0.76	0.70	0.95
1978 VW RABBIT CAL FU-INJ												
	NOX AVE	1.11	1.14	0.90	0.74	0.58	0.42	-	0.16	-	0.11	-
	NOXC AVE	0.84	0.86	0.78	0.61	0.58	0.41	-	0.41	-	0.53	-
1979 DODGE ASPEN CALIF.												
	NOX AVE	1.18	1.18	0.97	0.66	0.65	0.61	0.67	0.49	0.57	0.31	0.35
	NOXC AVE	0.89	0.85	0.71	0.57	0.59	0.62	0.68	0.57	0.66	0.67	0.74
1980 MERCURY PROTOTYPE												
	NOX AVE	-	0.55	0.61	0.51	0.52	0.48	0.58	0.50	0.55	0.37	0.49
	NOXC AVE	-	0.49	0.48	0.45	0.48	0.49	0.59	0.53	0.65	0.60	0.83
1980 BUICK REGAL PROTOTYPE												
	NOX AVE	-	0.97	1.30	1.21	1.14	0.99	1.15	0.76	0.92	0.26	0.37
	NOXC AVE	-	0.74	0.99	1.04	1.05	1.01	1.16	0.95	1.03	0.53	0.73
DATSUN PROTOTYPE												
	NOX AVE	1.40	1.07	1.01	0.88	0.78	0.61	-	0.52	-	0.31	-
	NOXC AVE	1.06	0.82	0.80	0.76	0.72	0.61	-	0.60	-	0.51	-

Highway Fuel Economy Test-NOX--

Table 52 shows the NOX emissions for the HFET procedure. While most of the cars produced maximum NOX emissions at low temperatures, some showed small changes in NOX emissions with temperature. The 1972 Chevrolet showed a maximum at 60°F (16°C). Nearly all of the cars showed an increase in NOX emissions when the air conditioners were used.

TABLE 52 HIGHWAY FUEL ECONOMY TEST - NITROGEN OXIDES G/KM

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	1.78	1.79	1.71	2.72	2.53	2.31	3.17	2.14	2.90	1.17	1.25
	1.81	1.89	1.66	1.47	1.26	1.10	1.61	0.99	1.59	0.60	1.04
AVE	1.80	1.84	1.69	2.10	1.90	1.71	2.39	1.57	2.25	0.89	1.14
1974 CHEVROLET IMPALA	1.36	1.27	1.20	1.03	1.06	0.85	.	0.73	.	0.40	.
	1.35	1.30	1.17	1.03	0.96	0.89	.	0.71	.	0.49	.
	.	.	.	0.98	.	.	.	.	.	.	.
AVE	1.36	1.29	1.19	1.01	1.01	0.87	.	0.72	.	0.45	.
1977 HONDA CIVIC 49 STATE	2.10	2.41	1.72	1.69	1.64	1.51	.	1.42	.	1.49	.
	2.08	2.08	1.75	1.88	1.76	1.47	.	1.42	.	1.41	.
AVE	2.09	2.25	1.73	1.78	1.70	1.49	.	1.42	.	1.45	.
1977 FORD LTD 49 STATE	0.48	0.53	0.52	0.57	0.56	0.50	0.45	0.36	0.44	0.24	0.31
	0.50	0.54	0.50	0.48	0.48	0.41	0.39	0.33	0.43	0.22	0.19
	0.51	.	.	.	.	.	.	.	.	.	.
AVE	0.49	0.53	0.51	0.53	0.52	0.45	0.42	0.35	0.43	0.23	0.25
1977 PLYMOUTH FURY 49S	0.79	0.90	0.80	0.59	0.63	0.72	.	0.71	.	0.69	.
	0.74	0.87	0.89	0.58	0.66	0.67	.	0.58	.	0.76	.
	.	.	.	0.57	0.61	.	.	.	.	.	.
AVE	0.77	0.88	0.84	0.58	0.63	0.69	.	0.65	.	0.73	.
1978 BUICK V6 TURBOCHARGE	1.24	1.18	0.81	0.73	0.70	0.59	0.72	0.37	0.58	0.11	0.15
	1.26	0.84	0.74	0.78	0.67	0.51	0.77	0.48	0.67	0.20	0.29
	1.23	.	.	.	.	.	.	.	.	.	.
AVE	1.24	1.01	0.77	0.75	0.68	0.55	0.75	0.43	0.63	0.15	0.22
1977 PLYMOUTH FURY CALIF	0.59	0.66	0.51	0.62	0.50	0.55	0.48	0.41	0.43	0.27	0.31
	0.61	0.80	0.47	0.51	0.48	0.45	0.48	0.37	0.44	0.16	0.31
	.	.	.	.	.	.	.	.	.	.	0.28
AVE	0.60	0.73	0.49	0.56	0.49	0.50	0.48	0.37	0.44	0.22	0.30
1978 CHEVROLET ST W-CALIF	0.72	0.67	0.57	0.58	0.54	0.48	0.61	0.46	0.57	0.39	0.40
	0.71	0.70	0.54	0.57	0.54	0.45	0.59	0.50	0.63	0.43	0.45
AVE	0.71	0.68	0.56	0.57	0.54	0.46	0.60	0.48	0.60	0.41	0.42
1978 FORD PINTO CAL 3 WAY	1.34	1.05	1.11	1.20	0.99	0.80	1.11	.	0.85	0.35	0.78
	1.15	0.61	0.49	1.17	0.83	0.73	1.05	0.52	0.85	0.58	0.91
	1.24	.	.	.	.	.	.	0.67	.	.	0.84
AVE	1.24	0.83	0.80	1.19	0.91	0.77	1.08	0.59	0.85	0.46	0.84
1978 VW RABBIT CAL FU-INJ	1.21	1.27	1.11	0.81	0.68	0.33	.	0.30	.	0.37	.
	1.14	1.17	1.23	0.97	0.62	0.32	.	0.38	.	0.36	.
AVE	1.17	1.22	1.17	0.89	0.65	0.32	.	0.34	.	0.37	.
1979 DODGE ASPEN CALIF.	1.00	1.03	0.97	0.84	0.81	0.77	0.85	0.71	0.87	0.23	0.49
	1.00	1.99	1.83	0.88	0.81	0.77	0.88	1.87	0.76	0.42	0.56
AVE	1.00	1.51	1.40	0.86	0.81	0.77	0.87	1.29	0.82	0.32	0.52
1980 MERCURY PROTOTYPE	.	0.39	0.31	0.34	0.27	0.22	0.30	0.25	0.34	0.23	0.29
	.	0.34	.	.	0.30	0.28	.	.	.	0.20	0.31
AVE	.	0.37	0.31	0.34	0.28	0.25	0.30	0.25	0.34	0.22	0.30
1980 BUICK REGAL PROTOTYP	.	1.12	0.84	0.77	0.60	0.48	0.56	0.38	0.48	0.16	0.29
	.	1.07	.	.	0.58	0.51	.	.	.	0.17	0.29
AVE	.	1.09	0.84	0.77	0.59	0.49	0.56	0.38	0.48	0.16	0.29
DATSUN PROTOTYPE	1.11	1.13	1.02	0.89	0.78	0.64	.	0.56	.	0.25	.
	1.16	1.08	0.97	0.90	0.81	0.61	.	0.52	.	0.22	.
	.	.	1.00	.	.	.	.	.	.	.	.
AVE	1.13	1.11	1.00	0.90	0.79	0.62	.	0.54	.	0.24	.

Table 53 compares the average measured NOX with the average corrected NOXC emissions. Again, the correction reduced NOX at the lower temperatures and increased NOX at the higher temperatures.

TABLE 53 HIGHWAY FUEL ECONOMY TESTAVERAGE NOX & NOXC - G/KM

	TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA												
	NOX AVE	1.80	1.84	1.69	2.10	1.90	1.71	2.39	1.57	2.25	0.89	1.14
	NOXC AVE	1.36	1.39	1.32	1.80	1.75	1.73	2.41	1.82	2.61	1.73	2.07
1974 CHEVROLET IMPALA												
	NOX AVE	1.36	1.29	1.19	1.01	1.01	0.87	.	0.72	.	0.45	.
	NOXC AVE	1.03	0.97	0.93	0.87	0.93	0.91	.	0.84	.	0.85	.
1977 HONDA CIVIC 49 STATE												
	NOX AVE	2.09	2.25	1.73	1.78	1.70	1.49	.	1.42	.	1.45	.
	NOXC AVE	1.57	1.70	1.37	1.52	1.56	1.49	.	1.66	.	2.28	.
1977 FORD LTD 49 STATE												
	NOX AVE	0.49	0.53	0.51	0.53	0.52	0.45	0.42	0.35	0.43	0.23	0.28
	NOXC AVE	0.37	0.41	0.41	0.45	0.48	0.48	0.44	0.41	0.53	0.44	0.47
1977 PLYMOUTH FURY 49S												
	NOX AVE	0.77	0.88	0.84	0.58	0.63	0.69	.	0.65	.	0.73	.
	NOXC AVE	0.58	0.67	0.67	0.51	0.58	0.70	.	0.75	.	1.21	.
1978 BUICK V6 TURBOCHARGE												
	NOX AVE	1.24	1.01	0.77	0.75	0.68	0.55	0.75	0.43	0.63	0.15	0.22
	NOXC AVE	0.93	0.77	0.62	0.64	0.63	0.56	0.77	0.50	0.74	0.26	0.38
1977 PLYMOUTH FURY CALIF												
	NOX AVE	0.60	0.73	0.49	0.56	0.49	0.50	0.48	0.41	0.44	0.22	0.30
	NOXC AVE	0.45	0.55	0.39	0.48	0.46	0.52	0.49	0.48	0.54	0.33	0.51
1978 CHEVROLET ST W-CALIF												
	NOX AVE	0.71	0.68	0.56	0.57	0.54	0.46	0.60	0.48	0.60	0.41	0.42
	NOXC AVE	0.54	0.52	0.44	0.49	0.49	0.47	0.61	0.57	0.71	0.74	0.72
1978 FORD PINTO CAL 3 WAY												
	NOX AVE	1.24	0.83	0.80	1.19	0.91	0.77	1.08	0.40	0.85	0.46	0.56
	NOXC AVE	0.94	0.63	0.63	1.02	0.84	0.78	1.11	0.46	0.98	0.81	0.87
1978 VW RABBIT CAL FU-INJ												
	NOX AVE	1.17	1.22	1.17	0.89	0.65	0.32	.	0.34	.	0.37	.
	NOXC AVE	0.88	0.92	0.91	0.76	0.60	0.33	.	0.30	.	0.63	.
1979 DODGE ASPEN CALIF.												
	NOX AVE	1.00	1.51	1.40	0.86	0.81	0.77	0.87	1.29	0.82	0.32	0.52
	NOXC AVE	0.76	1.15	1.06	0.75	0.74	0.78	0.88	1.49	0.96	0.70	1.12
1980 MERCURY PROTOTYPE												
	NOX AVE	.	0.37	0.31	0.34	0.28	0.25	0.30	0.25	0.34	0.22	0.30
	NOXC AVE	.	0.28	0.25	0.30	0.26	0.25	0.31	0.27	0.40	0.36	0.51
1980 BUICK REGAL PROTOTYP												
	NOX AVE	.	1.09	0.84	0.77	0.59	0.49	0.56	0.38	0.48	0.16	0.29
	NOXC AVE	.	0.83	0.67	0.66	0.54	0.50	0.56	0.42	0.53	0.33	0.56
DATSUN PROTOTYPE												
	NOX AVE	1.13	1.11	1.00	0.90	0.79	0.62	.	0.54	.	0.24	.
	NOXC AVE	0.86	0.84	0.79	0.78	0.73	0.64	.	0.62	.	0.42	.

Sulfate Emission Test-NOX--

Table 54 lists the NOX data for the SET procedure. This procedure operates at a more nearly warmed-up condition than the FTP and usually gave higher NOX emissions than the HFET. The increase in NOX with the use of air conditioners and reduction of NOX at 110°F (43°C) was again observed.

TABLE 54 SULFATE EMISSION TEST -NITROGEN OXIDES G/KM

	TEMPERATURE F	0	40	80	80AC	110	110AC
	(C)	(-18)	(4)	(27)	(27)	(43)	(43)
1972 CHEVROLET IMPALA		1.95	1.99	2.15	2.65	1.07	1.11
		2.00	1.81	1.28	1.71	0.60	0.97
	AVE	1.98	1.90	1.72	2.18	0.83	1.04
1974 CHEVROLET IMPALA		1.35	1.20	0.86	.	0.38	.
		1.32	1.21	0.81	.	0.42	.
	AVE	1.34	1.21	0.84	.	0.40	.
1977 HONDA CIVIC 49 STATE		2.51	2.22	1.82	.	1.64	.
		2.51	2.16	1.78	.	1.63	.
	AVE	2.51	2.19	1.80	.	1.64	.
1977 FORD LTD 49 STATE		0.62	0.62	0.64	0.60	0.28	0.41
		0.62	0.58	0.52	0.53	0.24	0.24
		0.61	.	.	.	.	.
	AVE	0.62	0.60	0.58	0.56	0.26	0.32
1977 PLYMOUTH FURY 49S		1.07	1.01	0.70	.	0.54	.
		1.02	1.22	0.72	.	0.58	.
	AVE	1.04	1.12	0.71	.	0.56	.
1978 BUICK V6 TURBOCHARGE		1.26	0.86	0.56	0.59	0.13	0.16
		1.32	0.73	0.51	0.66	0.28	0.29
		1.25	.	.	.	.	.
	AVE	1.28	0.80	0.53	0.62	0.20	0.23
1977 PLYMOUTH FURY CALIF		0.61	0.51	0.39	0.40	0.21	0.28
		0.69	0.45	0.41	0.46	0.19	0.24
		.	.	.	.	.	0.24
	AVE	0.65	0.48	0.40	0.43	0.20	0.25
1978 CHEVROLET ST W-CALIF		0.80	0.65	0.52	0.62	0.30	0.44
		0.79	0.62	0.54	0.67	0.35	0.42
	AVE	0.79	0.64	0.53	0.64	0.33	0.43
1978 FORD PINTO CAL 3 WAY		1.23	1.04	0.81	1.00	0.33	0.70
		1.12	0.49	0.76	0.94	0.52	0.71
		1.13	.	.	.	.	.
	AVE	1.16	0.77	0.79	0.97	0.42	0.71
1978 VW RABBIT CAL FU-INJ		1.10	0.86	0.38	.	0.34	.
		1.06	1.01	0.39	.	0.31	.
	AVE	1.08	0.93	0.38	.	0.32	.
1979 DODGE ASPEN CALIF.		0.97	0.85	0.65	0.74	0.33	0.39
		0.97	1.34	0.67	0.73	0.33	0.43
	AVE	0.97	1.10	0.66	0.73	0.33	0.41
1980 MERCURY PROTOTYPE		.	0.51	0.33	0.44	0.31	0.39
		.	0.51	0.39	0.44	0.32	0.49
	AVE	.	0.51	0.36	0.44	0.31	0.44
1980 BUICK REGAL PROTOTYP		.	0.90	0.55	0.71	0.21	0.38
		.	0.90	0.64	0.71	0.23	0.35
	AVE	.	0.90	0.60	0.71	0.22	0.37
DATSUN PROTOTYPE		1.25	1.02	0.56	.	0.18	.
		1.26	0.95	0.57	.	0.26	.
		1.25	0.97	0.57	.	0.22	.
	AVE	1.25	0.98	0.57	.	0.22	.

The comparison of the measured NOX with corrected NOXC is given in Table 55.

TABLE 55 SULFATE EMISSION TEST - AVERAGE NOX & NOXC - G/KM

TEMPERATURE F (C)	0 (-18)	40 (4)	80 (27)	80AC (27)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA						
NOX AVE	1.98	1.90	1.72	2.18	0.83	1.04
NOXC AVE	1.49	1.49	1.75	2.20	1.63	1.88
1974 CHEVROLET IMPALA						
NOX AVE	1.34	1.21	0.84	.	0.40	.
NOXC AVE	1.01	0.95	0.87	.	0.77	.
1977 HONDA CIVIC 49 STATE						
NOX AVE	2.51	2.19	1.80	.	1.64	.
NOXC AVE	1.89	1.73	1.79	.	2.58	.
1977 FORD LTD 49 STATE						
NOX AVE	0.62	0.60	0.58	0.56	0.26	0.32
NOXC AVE	0.46	0.48	0.61	0.59	0.49	0.61
1977 PLYMOUTH FURY 49S						
NOX AVE	1.04	1.12	0.71	.	0.56	.
NOXC AVE	0.78	0.69	0.72	.	0.94	.
1978 BUICK V6 TURBOCHARGE						
NOX AVE	1.28	0.80	0.53	0.62	0.20	0.23
NOXC AVE	0.96	0.64	0.55	0.64	0.34	0.39
1977 PLYMOUTH FURY CALIF						
NOX AVE	0.65	0.48	0.40	0.43	0.20	0.25
NOXC AVE	0.49	0.38	0.42	0.44	0.31	0.43
1978 CHEVROLET ST W-CALIF						
NOX AVE	0.79	0.64	0.53	0.64	0.33	0.43
NOXC AVE	0.60	0.50	0.54	0.66	0.59	0.64
1978 FORD PINTO CAL 3 WAY						
NOX AVE	1.16	0.77	0.79	0.97	0.42	0.71
NOXC AVE	0.87	0.61	0.80	1.00	0.75	1.10
1978 VW RABBIT CAL FU-INJ						
NOX AVE	1.08	0.93	0.38	.	0.32	.
NOXC AVE	0.61	0.73	0.39	.	0.55	.
1979 DODGE ASPEN CALIF.						
NOX AVE	0.97	1.10	0.66	0.73	0.33	0.41
NOXC AVE	0.73	0.83	0.68	0.74	0.73	0.87
1980 MERCURY PROTOTYPE						
NOX AVE	.	0.51	0.36	0.44	0.31	0.44
NOXC AVE	.	0.41	0.37	0.45	0.51	0.75
1980 BUICK REGAL PROTOTYP						
NOX AVE	.	0.90	0.60	0.71	0.22	0.37
NOXC AVE	.	0.71	0.61	0.72	0.43	0.73
DATSUN PROTOTYPE						
NOX AVE	1.25	0.98	0.57	.	0.22	.
NOXC AVE	0.95	0.77	0.58	.	0.40	.

New York City Cycle-NOX--

Table 56 summarizes the NOX data obtained using the NYCC. The average NOX emissions are compared to the corrected NOXC emissions in Table 57.

TABLE 56 NEW YORK CITY CYCLE -NITROGEN OXIDES G/KM

TEMPERATURE F	20	60	80	80AC	110	110AC
(C)	(-7)	(16)	(27)	(27)	(43)	(43)
1977 HONDA CIVIC 49 STATE	4.59	2.36	2.49	.	1.80	.
	3.09	3.16	2.42	.	2.03	.
AVE	3.84	2.76	2.46	.	1.92	.
1978 BUICK V6 TURBOCHARGE	1.34	0.75	0.59	0.61	0.14	0.16
	0.98	0.88	0.59	0.87	0.21	0.25
AVE	1.16	0.82	0.59	0.74	0.17	0.20
1978 FORD PINTO CAL 3 WAY	0.89	1.01	0.63	0.92	0.28	0.61
	0.70	1.03	0.69	0.73	0.41	0.52
AVE	0.79	1.02	0.66	0.83	0.34	0.56
1978 VW RABBIT CAL FU-INJ	1.39	0.67	0.48	.	0.29	.
	1.22	0.82	0.39	.	0.19	.
AVE	1.31	0.74	0.43	.	0.24	.
1979 DODGE ASPEN CALIF.	0.43	0.44	0.41	0.46	0.24	0.27
	1.17	0.42	0.43	0.47	0.26	0.33
AVE	0.80	0.43	0.42	0.47	0.25	0.30
1980 MERCURY PROTOTYPE	1.20	1.92	0.49	0.59	0.42	0.61
	1.08	1.92	0.50	0.59	0.36	0.61
AVE	1.14	1.92	0.49	0.59	0.39	0.61
1980 BUICK REGAL PROTOTYP	1.98	1.73	1.40	1.84	0.08	0.20
	1.84	1.73	1.40	1.84	0.22	0.17
AVE	1.91	1.73	1.40	1.84	0.15	0.19
DATSUN PROTOTYPE	1.22	1.07	0.87	.	0.25	.
	1.29	1.17	0.85	.	0.21	.
AVE	1.26	1.12	0.86	.	0.23	.

TABLE 57 NEW YORK CITY CYCLE - AVERAGE NOX & NOXC - G/KM

TEMPERATURE F (C)	0 (-18)	40 (4)	80 (27)	80AC (27)	110 (43)	110AC (43)
1977 HONDA CIVIC 49 STATE						
NOX AVE	3.84	2.76	2.46	.	1.92	.
NOXC AVE	2.91	2.36	2.45	.	3.01	.
1978 BUICK V6 TURBOCHARGE						
NOX AVE	1.16	0.82	0.59	0.74	0.17	0.20
NOXC AVE	0.88	0.70	0.61	0.76	0.29	0.35
1978 FORD PINTO CAL 3 WAY						
NOX AVE	0.79	1.02	0.66	0.83	0.34	0.56
NOXC AVE	0.60	0.87	0.67	0.85	0.60	0.88
1978 VW RABBIT CAL FU-INJ						
NOX AVE	1.31	0.74	0.43	.	0.24	.
NOXC AVE	0.99	0.63	0.44	.	0.40	.
1979 DODGE ASPEN CALIF.						
NOX AVE	0.80	0.43	0.42	0.47	0.25	0.30
NOXC AVE	0.61	0.38	0.43	0.48	0.54	0.65
1980 MERCURY PROTOTYPE						
NOX AVE	1.14	1.92	0.49	0.59	0.39	0.61
NOXC AVE	0.87	1.66	0.50	0.60	0.64	1.04
1980 BUICK REGAL PROTOTYP						
NOX AVE	1.91	1.73	1.40	1.84	0.15	0.19
NOXC AVE	1.46	1.48	1.43	1.86	0.30	0.37
DATSUN PROTOTYPE						
NOX AVE	1.26	1.12	0.86	.	0.23	.
NOXC AVE	0.96	0.96	0.88	.	0.42	.

Federal Short Cycle-NOX--

Table 58 presents the NOX emissions for the FSC. Only the 1977 (49 State) and California Plymouths had NOX emissions at 80°F (27°C) that were comparable to the composite FTP results. All of the other results showed NOX emissions less than those found with the composite FTP.

TABLE 58 FEDERAL SHORT CYCLE - NITROGEN OXIDES G/KM

TEMPERATURE F	0	40	(80)	110
(C)	(-18)	(4)	(27)	(43)
1972 CHEVROLET IMPALA	1.56	1.54	1.37	0.59
	1.65	1.46	0.97	0.20
AVE	1.61	1.50	1.17	0.39
1974 CHEVROLET IMPALA	1.08	0.82	0.61	0.20
	1.00	0.83	0.57	0.33
AVE	1.04	0.83	0.59	0.26
1977 FORD LTD	0.86	0.67	0.63	0.40
	0.87	0.68	0.51	0.14
	0.85	•	•	•
AVE	0.86	0.68	0.57	0.27
1977 PLYMOUTH FURY 49S	1.23	0.72	0.91	0.27
	1.02	1.73	0.94	0.37
AVE	1.12	1.23	0.92	0.32
1977 PLYMOUTH FURY CALIF	0.64	0.58	0.55	0.16
	0.73	0.69	0.69	0.13
AVE	0.68	0.63	0.62	0.14
1978 CHEVROLET ST W-CALIF	0.56	0.46	0.42	0.14
	0.56	0.44	0.41	0.19
AVE	0.56	0.45	0.42	0.17

Table 59 compares the average measured NOX emissions with the average corrected NOXC emissions.

TABLE 59 FEDERAL SHORT CYCLE - AVERAGE NOX & NOXC - G/KM

	TEMPERATURE F (C)	0 (-18)	40 (4)	80 (27)	80AC (27)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA							
	NOX AVE	1.61	1.50	1.17	0.00	0.39	0.00
	NOXC AVE	1.21	1.18	1.19	0.00	0.77	0.00
1974 CHEVROLET IMPALA							
	NOX AVE	1.04	0.83	0.59	•	0.26	•
	NOXC AVE	0.79	0.65	0.62	•	0.50	•
1977 FORD LTD 49 STATE							
	NOX AVE	0.86	0.68	0.57	0.28	0.27	0.00
	NOXC AVE	0.64	0.54	0.60	0.29	0.50	0.00
1977 PLYMOUTH FURY 49S							
	NOX AVE	1.12	1.23	0.92	•	0.32	•
	NOXC AVE	0.84	0.98	0.94	•	0.53	•
1977 PLYMOUTH FURY CALIF							
	NOX AVE	0.68	0.63	0.62	0.00	0.14	0.00
	NOXC AVE	0.52	0.50	0.64	0.00	0.23	0.00
1978 CHEVROLET ST W-CALIF							
	NOX AVE	0.56	0.45	0.42	0.00	0.17	0.00
	NOXC AVE	0.42	0.36	0.42	0.00	0.30	0.00

Steady State-NOX--

These data are not normally obtained during inspection tests. They are presented here to serve as a baseline for other studies.

80 km/h (50 mph), loaded, steady state-NOX--Data in Table 60 show the concentrations in ppm of the NOX obtained at 80 km/h (50 mph). Most of the data showed poor reproducibility. In general, NOX concentration decreased with ambient temperature at constant relative humidity.

TABLE 60 80 KM/H (50 MPH), LOADED, STEADY STATE - NITROGEN OXIDES PPM

TEMPERATURE F		0	40	80	110
	(C)	(-18)	(4)	(27)	(43)
1972 CHEVROLET IMPALA		1659	1529	2229	14
		1670	1508	1106	482
	AVE	1765	1519	1668	248
1974 CHEVROLET IMPALA		913	669	352	264
		833	826	525	325
	AVE	873	748	439	295
1977 FORD LTD		210	224	224	115
		259	190	169	8
		229			
	AVE	233	207	197	62
1977 PLYMOUTH FURY 49S		532	437	526	745
		439	390	429	1066
	AVE	486	414	478	906
1977 PLYMOUTH FURY CALIF		354	291	224	96
		292	287	231	42
	AVE	323	289	228	69
1978 CHEVROLET ST W-CALIF		506	422	317	144
		500	372	365	198
	AVE	503	397	341	171

48 km/h (30 mph), loaded, steady state-NOX--The NOX concentrations at 48 km/h (30 mph) are given in Table 61. With the exception of both Plymouths, NOX concentrations were lower at 48 km/h (30 mph) than at 80 km/h (50 mph).

TABLE 61 48 KM/H (30 MPH), LOADED, STEADY STATE - NITROGEN OXIDES PPM

TEMPERATURE F		0	40	80	110
	(C)	(-18)	(4)	(27)	(43)
1972 CHEVROLET IMPALA		1081	695	959	470
		1007	786	555	181
	AVE	1044	742	757	325
1974 CHEVROLET IMPALA		76	368	155	161
		425	363	352	186
	AVE	251	366	254	174
1977 FORD LTD		18	176	135	83
		169	161	134	2
		167	.	.	.
	AVE	118	168	135	43
1977 PLYMOUTH FURY 495		174	23	2055	1240
		162	167	2561	1600
	AVE	168	95	2308	1420
1977 PLYMOUTH FURY CALIF		572	421	531	259
		405	436	618	80
	AVE	489	429	574	169
1978 CHEVROLET ST W-CALIF		199	169	181	96
		180	145	189	132
	AVE	189	157	185	114

2500 rpm, unloaded, steady state-NOX--The concentrations of NOX at 2500 rpm are presented in Table 62. This unloaded condition gave low NOX concentrations. This result was not unexpected since nitrogen fixation has been shown to depend more on engine load than on any other factor (21).

TABLE 62 2500 RPM, UNLOADED, STEADY STATE - NITROGEN OXIDES PPM

TEMPERATURE F (C)		0 (-18)	40 (4)	80 (27)	110 (43)
1972 CHEVROLET IMPALA		261	159	71	114
		235	182	127	101
	AVE	248	170	99	107
1974 CHEVROLET IMPALA		42	93	70	55
		105	94	86	31
	AVE	74	94	78	43
1977 FORD LTD		110	56	113	80
		108	119	95	1
		115			
	AVE	111	88	104	41
1977 PLYMOUTH FURY 49S		106	193	333	68
		113	181	339	215
	AVE	110	187	336	142
1977 PLYMOUTH FURY CALIF		90	74	94	52
		75	77	100	51
	AVE	82	75	97	52
1978 CHEVROLET ST W-CALIF		51	56	73	46
		52	36	69	54
	AVE	52	46	71	50

Idle in drive, steady state-NOX--Table 63 lists the NOX concentrations when the idle is in drive. Except for the 1977 Ford, the concentrations were comparable to the results obtained at 2500 rpm (See Table 62).

TABLE 63 IDLE, IN DRIVE, STEADY STATE - NITROGEN OXIDES PPM

TEMPERATURE F (C)	0 (-18)	40 (4)	80 (27)	110 (43)
1972 CHEVROLET IMPALA	185	163	121	92
	174	160	143	77
AVE	180	162	132	85
1974 CHEVROLET IMPALA	76	69	43	52
	76	66	58	44
AVE	76	68	51	48
1977 FORD LTD	794	167	77	373
	789	753	665	80
	754			
AVE	779	460	371	227
1977 PLYMOUTH FURY 49S	103	210	106	110
	115	149	123	63
AVE	109	180	115	87
1977 PLYMOUTH FURY CALIF	80	93	74	59
	98	77	78	55
AVE	89	85	76	57
1978 CHEVROLET ST W-CALIF	62	55	69	61
	66	50	63	55
AVE	64	53	66	58

Idle in neutral, steady state-NOX--Tables 64 and 65 show the NOX concentrations at idle. The first set of data were obtained before the 2500 rpm condition was run while the second was run after the 2500 rpm condition. Results between the two tables agreed reasonably well and the reproducibility was good. However, concentrations were all low, even for the 1977 Ford.

TABLE 64 IDLE, IN NEUTRAL, STEADY STATE* - NITROGEN OXIDES PPM

TEMPERATURE F (C)		0 (-18)	40 (4)	80 (27)	110 (43)
1972 CHEVROLET IMPALA		82	84	71	50
		82	74	67	54
	AVE	82	79	69	52
1974 CHEVROLET IMPALA		42	28	42	35
		44	38	37	33
	AVE	43	38	40	34
1977 FORD LTD		227	177	263	27
		198	216	117	44
		186			
	AVE	204	197	190	36
1977 PLYMOUTH FURY 49S		71	74	61	52
		83	69	62	42
	AVE	77	72	62	47
1977 PLYMOUTH FURY CALIF		50	47	46	40
		72	46	50	41
	AVE	61	47	48	40
1978 CHEVROLET ST W-CALIF		26	28	30	31
		31	23	31	27
	AVE	28	26	31	29

*BEFORE 2500 RPM CONDITION

TABLE 65 IDLE, IN NEUTRAL, STEADY STATE* - NITROGEN OXIDES PPM

TEMPERATURE F (C)		0 (-18)	40 (4)	80 (27)	110 (43)
1972 CHEVROLET IMPALA		84	75	72	48
		79	64	66	57
	AVE	82	70	69	53
1974 CHEVROLET IMPALA		42	37	39	33
		44	37	34	31
	AVE	43	37	37	32
1977 FORD LTD		229	175	129	103
		203	208	132	118
		194			
	AVE	209	192	131	111
1977 PLYMOUTH FURY 49S		64	75	61	48
		83	70	59	49
	AVE	74	73	60	49
1977 PLYMOUTH FURY CALIF		48	46	43	41
		48	44	46	40
	AVE	48	45	45	40
1978 CHEVROLET ST W-CALIF		25	20	29	74
		59	22	26	25
	AVE	42	21	28	49

*AFTER 2500 RPM CONDITION

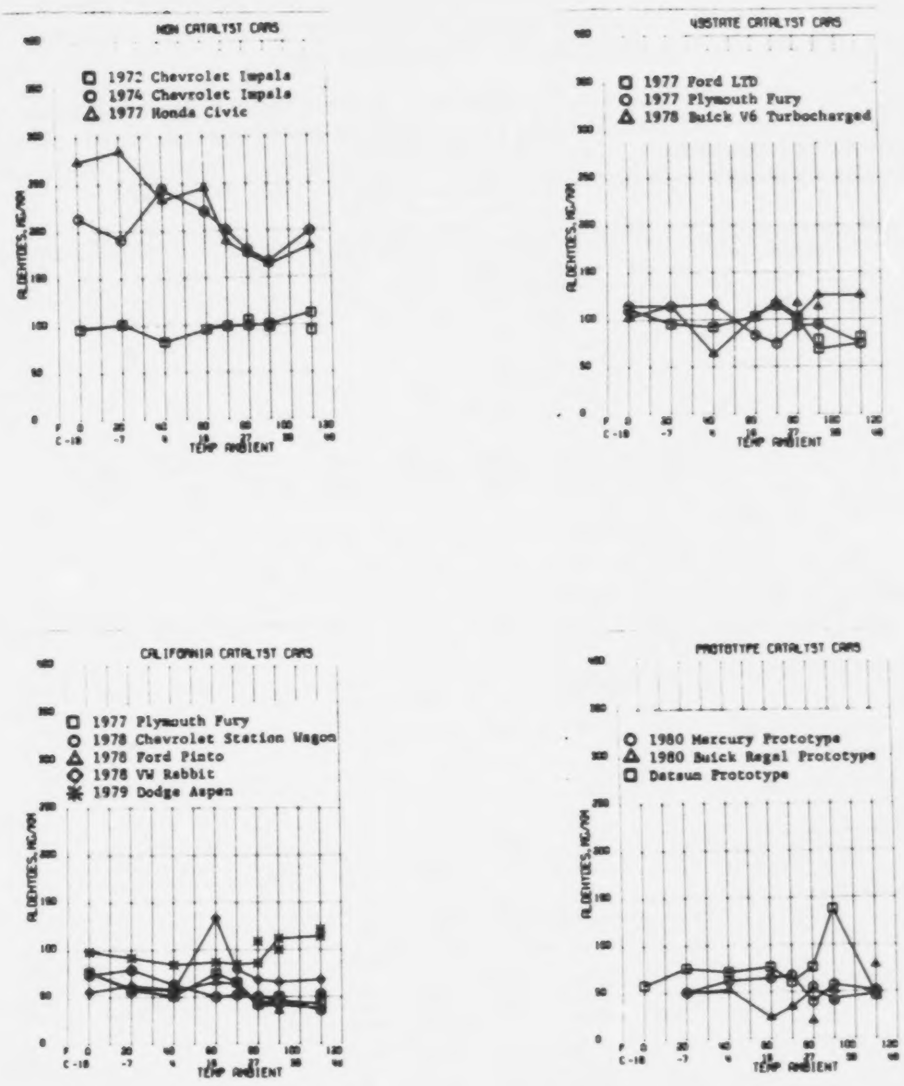
Unregulated Emissions

Federal Test Procedure-Aldehydes--

Table 66 and Figure 12 give the aldehyde emissions in mg/km for the composite FTP. The 1974 Chevrolet and the Honda showed the greatest aldehyde emissions; they were noncatalyst cars. Air conditioning generally showed greater aldehyde emissions at 80 and 110°F (27 and 43°C) but less at 90°F (32°C). The total range for average values varied from 19 mg/km in the 1980 Buick prototype to 285 mg/km in the Honda. The car with the lowest aldehyde emissions, the 1980 Buick, had a range from 19 to 78 mg/km. The Honda, with the highest aldehyde emissions, ranged from 164 to 285 mg/km.

TABLE 66 FTP COMPOSITE - ALDEHYDES MG/KM

TEMPERATURE F	0	20	40	60	70	80	80AC	90	90AC	110	110AC
(C)	(-18)	(-7)	(4)	(16)	(21)	(27)	(27)	(32)	(32)	(43)	(43)
1972 CHEVROLET IMPALA	92.64	103.31	79.55	100.81	109.84	116.60	127.54	124.29	118.12	136.98	98.40
	100.41	99.84	85.03	90.07	88.19	82.36	84.41	77.15	77.51	88.30	89.39
AVE	96.53	101.57	82.29	95.44	99.01	99.48	105.97	100.72	97.82	112.64	93.89
1974 CHEVROLET IMPALA	244.21	206.56	202.87	139.19	142.30	148.10	.	158.05	.	198.97	.
	184.07	175.04	285.26	260.27	260.16	211.13	.	176.41	.	200.34	.
	.	.	.	263.16	.	.	.	.	.	.	.
AVE	214.14	190.80	244.07	220.94	201.23	179.61	.	167.23	.	199.66	.
1977 HONDA CIVIC 49 STATE	277.22	322.44	192.83	276.38	141.30	170.94	.	152.50	.	170.83	.
	270.85	247.61	272.30	214.57	235.88	179.38	.	175.55	.	195.23	.
AVE	274.04	285.03	232.56	245.48	188.59	175.16	.	164.03	.	183.03	.
1977 FORD LTD 49 STATE	149.97	106.80	99.96	110.32	118.96	91.79	95.03	70.01	82.37	81.10	81.76
	113.36	84.46	84.50	96.33	111.69	107.41	109.25	66.77	75.16	66.94	81.24
	70.11	.	.	.	.	.	.	.	.	.	.
AVE	111.15	95.63	92.23	103.32	115.32	99.60	102.14	68.39	78.76	74.02	81.50
1977 PLYMOUTH FURY 49S	121.31	114.37	102.92	81.47	82.76	82.89	.	88.85	.	62.75	.
	108.08	.	130.41	102.24	92.88	103.21	.	100.42	.	85.99	.
	.	.	.	65.25	46.86	.	.	.	.	.	.
AVE	114.69	114.37	116.66	82.99	74.17	93.05	.	94.64	.	74.37	.
1978 BUICK V6 TURBOCHARGE	77.75	118.76	62.98	146.89	171.76	137.63	138.58	136.51	135.71	157.31	127.56
	119.52	111.38	64.40	60.03	66.36	70.22	95.60	115.13	90.28	93.34	123.17
	111.41	.	.	.	.	.	.	.	.	.	.
AVE	102.89	115.07	63.69	103.46	119.06	103.92	117.09	125.82	112.99	125.32	125.37
1977 PLYMOUTH FURY CALIF	74.91	57.53	56.85	86.61	69.10	45.34	47.37	43.10	44.18	35.37	46.53
	77.82	57.15	45.19	62.87	61.15	40.72	45.98	47.92	55.84	50.31	58.01
	.	.	.	.	.	.	.	.	.	.	49.08
AVE	76.37	57.34	51.02	74.74	65.12	43.03	46.68	47.92	50.01	42.84	51.21
1978 CHEVROLET ST W-CALIF	69.38	63.03	64.65	49.33	46.24	44.20	39.12	35.21	37.25	30.95	54.99
	78.53	95.16	61.59	50.74	57.35	56.68	58.82	59.14	63.56	40.81	50.88
AVE	73.95	79.09	63.12	50.04	51.79	50.44	48.97	47.18	50.40	35.88	52.94
1978 FORD PINTO CAL 3 WAY	73.14	57.17	68.17	63.59	50.61	33.22	31.92	50.37	38.43	42.34	45.67
	69.83	61.14	45.40	67.95	77.29	47.07	57.02	44.46	31.64	34.56	31.08
	85.00	.	.	.	.	.	.	29.95	.	.	81.20
AVE	75.99	59.16	56.79	65.77	63.95	40.15	44.47	41.59	35.04	38.45	52.65
1978 VW RABBIT CAL FU-INJ	51.14	48.11	57.80	97.28	98.90	70.15	.	78.18	.	83.62	.
	60.66	76.32	57.50	169.48	58.71	66.34	.	53.00	.	53.16	.
AVE	55.90	62.22	57.65	133.38	78.81	68.25	.	65.59	.	68.39	.
1979 DODGE ASPEN CALIF.	116.80	111.75	96.35	77.24	73.22	80.79	129.12	141.14	99.15	115.22	105.58
	79.73	71.46	72.15	96.45	96.40	90.93	89.07	82.75	101.20	113.03	138.13
AVE	98.26	91.61	84.25	86.85	84.81	85.86	109.10	111.95	100.17	114.12	121.85
1980 MERCURY PROTOTYPE	.	48.12	62.25	64.75	59.06	41.49	54.96	57.73	41.08	62.87	44.93
	.	52.49	.	.	75.67	37.83	.	.	.	39.42	57.72
AVE	.	50.31	62.25	64.75	67.37	39.66	54.96	57.73	41.08	51.14	51.33
1980 BUICK REGAL PROTOTYP	.	59.19	52.88	23.01	41.69	50.17	19.19	42.79	51.15	56.78	54.36
	.	40.76	.	.	26.83	53.78	.	.	.	39.16	102.01
AVE	.	49.97	52.88	23.01	34.26	51.98	19.19	42.79	51.15	47.97	78.18
DATSUN PROTOTYPE	53.02	100.80	76.32	57.06	45.56	40.17	.	150.27	.	64.22	.
	62.66	49.97	57.01	95.64	75.38	112.41	.	125.83	.	28.04	.
	.	.	80.84	.	.	.	.	.	.	.	.
AVE	57.84	75.38	71.39	76.35	60.47	76.29	.	138.05	.	46.13	.



(Data points not connected by a line are results of air conditioning runs.)

Figure 12. Effect of ambient temperature on aldehyde emissions for the composite FTP.

Federal Test Procedure-Hydrogen Sulfide--

The first four cars tested were evaluated with a gas chromatographic procedure that was known to work with hydrocarbon gases. Unfortunately, nitrogen oxides found in automotive exhaust gas destroyed the H_2S. We were not aware of the problem until these cars had been tested. Therefore, there are no data available for these four cars.

With four exceptions, every test on the remaining cars gave hydrogen sulfide concentrations that were below the sensitivity level of the EPA recommended procedure. All of the other values listed in Table 67 are based on the minimum detectability levels of the procedure.

TABLE 67 FTP COMPOSITE - HYDROGEN SULFIDE MG/KM

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.
AVE	.	.	.	.	.	.	.	.	.	.	.
1974 CHEVROLET IMPALA	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.
AVE	.	.	.	.	.	.	.	.	.	.	.
1977 HONDA CIVIC 49 STATE	0.24	0.25	0.26	0.26	0.27	0.25	.	0.25	.	0.25	.
	0.23	0.23	0.23	0.25	0.25	0.25	.	0.26	.	0.25	.
AVE	0.23	0.24	0.25	0.26	0.26	0.25	.	0.25	.	0.25	.
1977 FORD LTD 49 STATE	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.
AVE	.	.	.	.	.	.	.	.	.	.	.
1977 PLYMOUTH FURY 49S	0.08	0.03	0.10	.	.	.	.	.	.	.	.
	0.02	.	0.03	0.03	0.21	0.03	.	0.03	.	0.03	.
	.	.	.	0.03	0.03	.	.	.	.	.	.
AVE	0.05	0.03	0.06	0.03	0.12	0.03	.	0.03	.	0.03	.
1978 BUICK V6 TURBOCHARGE	0.24	0.25	0.24	0.25	0.25	0.24	0.25	0.27	0.29	10.06	0.29
	17.93	0.25	0.25	0.26	0.27	0.27	0.27	0.27	0.28	0.29	0.28
	0.22	.	.	.	.	.	.	.	.	.	.
AVE	6.13	0.25	0.25	0.25	0.26	0.26	0.26	0.27	0.29	5.17	0.28
1977 PLYMOUTH FURY CALIF	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.
AVE	.	.	.	.	.	.	.	.	.	.	.
1978 CHEVROLET ST W-CALIF	0.22	0.22	0.28	0.26	0.27	1.30	9.58	0.27	0.26	0.27	0.26
	0.25	.	0.26	0.30	0.30	0.27	0.28	0.27	0.27	0.26	0.26
AVE	0.24	0.22	0.27	0.28	0.28	0.78	4.93	0.27	0.26	0.26	0.26
1978 FORD PINTO CAL 3 WAY	0.24	0.26	0.25	0.23	0.25	0.23	0.24	0.25	0.23	0.27	0.26
	0.24	0.25	0.24	0.25	0.26	0.25	0.24	0.25	0.28	0.25	0.27
	0.25	.	.	.	.	.	.	0.27	.	.	0.26
AVE	0.24	0.25	0.25	0.24	0.25	0.24	0.24	0.25	0.25	0.26	0.26
1978 VW RABBIT CAL FU-INJ	0.26	0.27	0.26	0.26	0.26	0.26	.	0.26	.	0.26	.
	0.26	0.24	0.25	0.26	0.26	0.26	.	0.26	.	0.26	.
AVE	0.26	0.25	0.25	0.26	0.26	0.26	.	0.26	.	0.26	.
1979 DODGE ASPEN CALIF.	0.25	0.24	0.24	0.24	0.23	0.24	0.22	0.24	0.24	0.23	0.23
	0.23	0.24	0.24	0.24	0.24	0.27	0.26	0.24	0.23	0.22	0.22
AVE	0.24	0.24	0.24	0.24	0.24	0.25	0.24	0.24	0.23	0.22	0.23
1980 MERCURY PROTOTYPE	.	0.25	0.27	0.25	0.26	0.26	0.26	0.25	0.25	0.27	0.28
	.	0.24	.	.	0.27	0.25	.	.	.	0.27	0.27
AVE	.	0.24	0.27	0.25	0.26	0.26	0.26	0.25	0.25	0.27	0.27
1980 BUICK REGAL PROTOTYP	.	0.27	0.26	0.27	0.26	0.27	0.28	0.28	0.27	0.26	0.38
	.	0.29	.	.	0.26	0.28	.	.	.	0.25	0.24
AVE	.	0.28	0.26	0.27	0.26	0.27	0.28	0.28	0.27	0.26	0.31
DATSUN PROTOTYPE	0.23	0.24	0.24	0.24	0.26	0.25	.	0.23	.	0.25	.
	0.25	0.24	0.24	0.26	0.24	0.25	.	0.26	.	0.25	.
	.	.	0.25	.	.	.	.	.	.	.	.
AVE	0.24	0.24	0.24	0.25	0.25	0.25	.	0.24	.	0.25	.

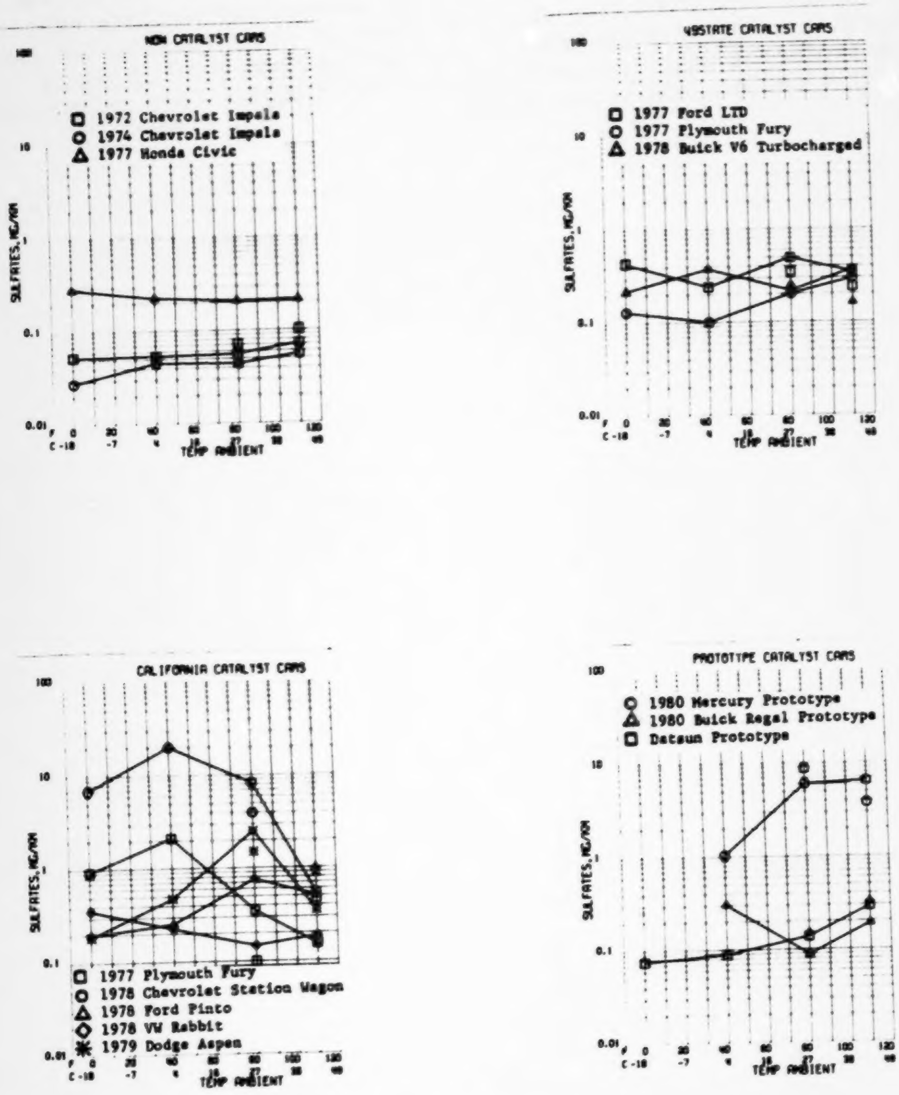
Sulfate Emission Test-Sulfate--

Table 68 and Figure 13 show the sulfate emissions in mg/km. The noncatalyst 1972 and 1974 Chevrolets had very low sulfate emissions. The Honda had at least three times the sulfate obtained with the two noncatalyst Chevrolets.

Of the catalyst equipped cars, only the 1978 Chevrolet, the 1980 prototype Mercury, the 1977 (California) Plymouth, and the 1979 Dodge Aspen produced sulfate emissions greater than 1 mg/km. There is no clear relationship between sulfate formation and ambient temperature. The 1978 Chevrolet and the 1977 (California) Plymouth had the most sulfate at 40°F (4°C). The other two cars produced over 1 mg/km of sulfate at 80°F (27°C), with and without the air conditioning. The Datsun, the 1980 prototype Buick, the VW and the 1977 (49 State) Plymouth gave sulfate emissions as low as those obtained with the two noncatalyst cars.

TABLE 68 SULFATE EMISSION TEST - SULFATES MG/KM

	TEMPERATURE F	0	40	80	80AC	110	110AC
	(C)	(-18)	(4)	(27)	(27)	(43)	(43)
1972 CHEVROLET IMPALA		0.06	0.05	0.06	0.09	0.10	0.12
		0.05	0.05	0.05	0.05	0.04	0.09
	AVE	0.05	0.05	0.06	0.07	0.07	0.10
1974 CHEVROLET IMPALA		0.03	0.02	0.05	.	0.06	.
		0.03	0.07	0.04	.	0.05	.
	AVE	0.03	0.05	0.04	.	0.06	.
1977 HONDA CIVIC 49 STATE		0.42	0.30	0.20	.	0.25	.
		0.16	0.15	0.21	.	0.17	.
	AVE	0.29	0.23	0.21	.	0.21	.
1977 FORD LTD 49 STATE		0.77	0.27	0.69	0.35	0.58	0.27
		0.30	0.21	0.29	0.34	0.10	0.21
		0.22	.	.	.	.	.
	AVE	0.43	0.24	0.49	0.35	0.34	0.24
1977 PLYMOUTH FURY 49S		0.14	0.12	0.19	.	0.30	.
		0.12	0.08	0.21	.	0.28	.
	AVE	0.13	0.10	0.20	.	0.29	.
1978 BUICK V6 TURBOCHARGE		0.24	0.41	0.24	0.29	0.39	0.20
		0.18	0.34	0.19	0.20	0.34	0.12
		0.25	.	.	.	.	.
	AVE	0.22	0.37	0.22	0.25	0.36	0.16
1977 PLYMOUTH FURY CALIF		1.06	1.83	0.28	0.08	0.18	0.15
		0.78	2.40	0.42	0.12	0.13	0.16
		.	.	.	.	.	0.18
	AVE	0.92	2.11	0.35	0.10	0.15	0.16
1978 CHEVROLET ST W-CALIF		8.99	23.18	8.16	3.11	0.78	0.48
		4.92	17.18	8.35	4.77	0.30	0.42
	AVE	6.96	20.18	8.25	3.94	0.54	0.45
1978 FORD PINTO CAL 3 WAY		0.15	0.22	0.36	0.58	0.64	1.26
		0.17	0.29	1.15	0.89	0.37	0.72
		0.27	.	.	.	.	.
	AVE	0.20	0.25	0.76	0.74	0.50	0.99
1978 VW RABBIT CAL FU-INJ		0.38	0.31	0.13	.	0.16	.
		0.33	0.14	0.16	.	0.21	.
	AVE	0.36	0.22	0.15	.	0.18	.
1979 DODGE ASPEN CALIF.		0.20	0.24	1.69	0.95	0.35	0.40
		0.18	0.71	3.36	2.07	0.35	1.40
	AVE	0.19	0.48	2.52	1.51	0.35	0.90
1980 MERCURY PROTOTYPE		.	1.04	8.16	8.86	3.97	2.29
		.	.	3.98	.	9.06	5.25
	AVE	.	1.04	6.07	8.86	6.51	3.77
1980 BUICK REGAL PROTOTYP		.	0.30	0.11	0.15	0.21	0.40
		.	.	0.07	.	0.17	0.25
	AVE	.	0.30	0.09	0.15	0.19	0.32
DATSUN PROTOTYPE		0.09	0.09	0.12	.	0.34	.
		0.06	0.09	0.15	.	0.24	.
		.	0.09	.	.	.	.
	AVE	0.08	0.09	0.14	.	0.29	.



(Data points not connected by a line are results of air conditioning runs.)

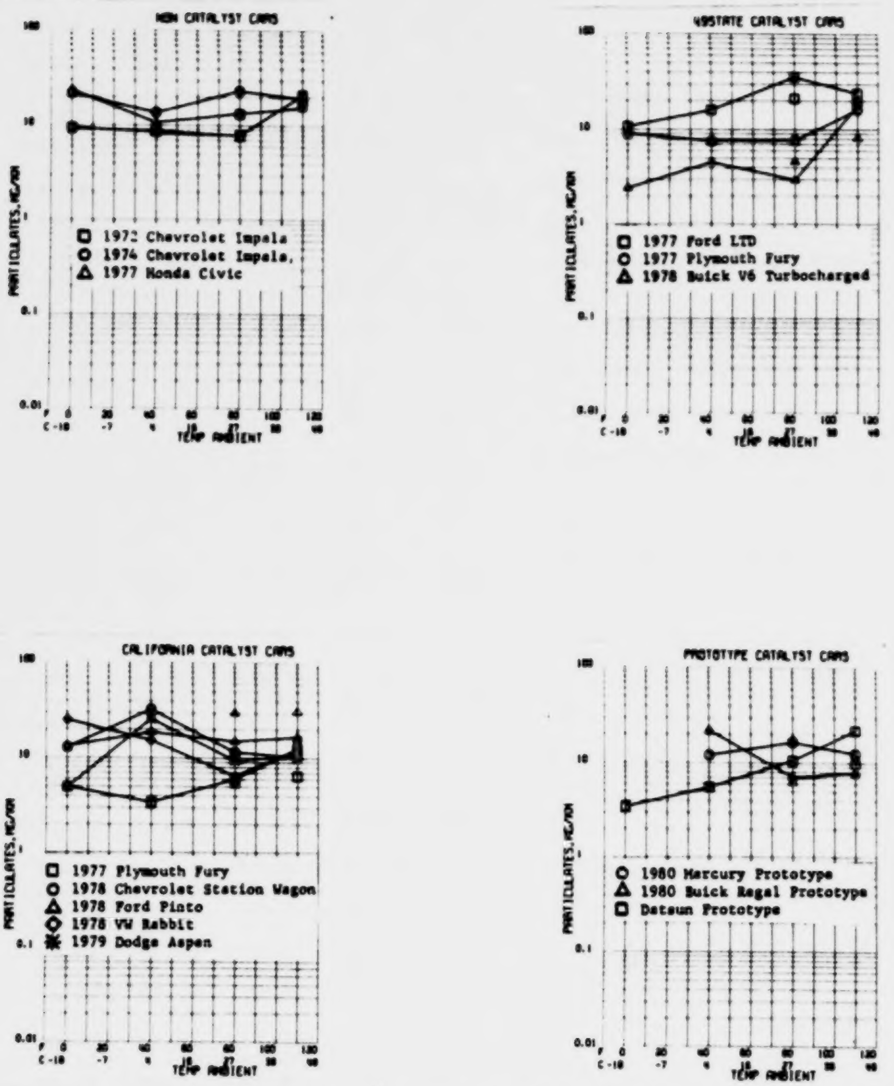
Figure 13. Effect of ambient temperature on sulfate emissions for the sulfate emission test.

Sulfate Emission Test-Particulates--

The particulate emissions, listed in Table 69 and illustrated in Figure 14, show a variety of results. The noncatalyst cars, even though they were run on unleaded gasoline, had average particulate emissions that varied from 8 to 23 mg/km. The three 49 State cars varied from 2 to 36 mg/km and the five California cars varied from 3 to 33 mg/km. The three prototype vehicles varied from 3 to 22 mg/km. Air conditioning did not produce a consistent effect.

TABLE 69 SULFATE EMISSION TEST - PARTICULATES MG/KM

TEMPERATURE F (C)	0 (-18)	40 (4)	80 (27)	80AC (27)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	7.91	9.65	10.17	10.43	30.95	11.44
	10.80	7.54	5.58	16.35	11.56	24.65
AVE	9.36	8.59	7.88	13.39	21.25	18.05
1974 CHEVROLET IMPALA	23.97	17.82	15.38	.	22.50	.
	19.44	9.53	31.32	.	16.25	.
AVE	21.70	13.67	23.35	.	19.37	.
1977 HONDA CIVIC 49 STATE	32.58	13.82	15.26	.	22.04	.
	14.29	7.60	11.73	.	9.13	.
AVE	23.43	10.71	13.50	.	15.58	.
1977 FORD LTD 49 STATE	1.90	20.07	55.76	24.23	38.14	24.10
	19.06	11.96	15.41	18.20	9.93	14.77
	11.31	.	.	.	.	.
AVE	10.75	16.02	35.59	21.22	24.03	19.44
1977 PLYMOUTH FURY 49S	10.38	7.47	7.29	.	16.67	.
	7.82	7.65	7.96	.	15.60	.
AVE	9.10	7.56	7.63	.	16.14	.
1978 BUICK V6 TURBOCHARGE	2.61	4.85	4.42	4.50	11.64	8.30
	1.49	4.20	1.48	4.66	24.00	7.84
	3.14	.	.	.	.	.
AVE	2.41	4.53	2.95	4.58	17.82	8.07
1977 PLYMOUTH FURY CALIF	8.00	1.61	8.44	6.46	10.79	2.79
	1.92	5.20	3.63	4.97	14.63	15.58
	.	.	.	.	.	1.19
AVE	4.96	3.40	6.03	5.72	12.71	6.52
1978 CHEVROLET ST W-CALIF	18.02	33.97	14.12	12.60	8.82	0.28
	7.72	31.43	9.15	8.23	11.72	22.48
AVE	12.87	32.70	11.64	10.41	10.27	11.38
1978 FORD PINTO CAL 3 WAY	8.96	12.37	21.67	48.05	12.76	9.82
	13.53	25.33	8.52	12.15	20.89	52.26
	17.35	.	.	.	.	.
AVE	13.28	18.85	15.10	30.10	16.82	31.04
1978 VW RABBIT CAL FU-INJ	25.46	23.81	5.63	.	10.11	.
	24.75	6.95	7.38	.	14.63	.
AVE	25.10	15.38	6.50	.	12.37	.
1979 DODGE ASPEN CALIF.	4.00	6.74	7.00	10.17	12.49	13.71
	5.80	45.39	11.95	11.01	8.86	16.92
AVE	4.90	26.06	9.47	10.59	10.67	15.31
1980 MERCURY PROTOTYPE	.	12.04	22.07	16.69	8.82	8.37
	.	.	10.95	.	16.34	11.07
AVE	.	12.04	16.51	16.69	12.58	9.72
1980 BUICK REGAL PROTOTYP	.	22.00	3.56	6.24	7.89	10.24
	.	.	10.58	.	7.80	12.45
AVE	.	22.00	7.07	6.24	7.85	11.34
DATSUN PROTOTYPE	4.06	6.69	9.24	.	26.71	.
	2.75	3.39	11.95	.	17.43	.
	.	6.42	.	.	.	.
AVE	3.41	5.50	10.60	.	22.07	.



(Data points not connected by a line are results of air conditioning runs.)

Figure 14. Effect of ambient temperature on particulate emissions for the sulfate emission test.

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Hydrocarbons by Chromatography--

Tables 16, 17 and 18 (presented earlier) show the hydrocarbon emissions in g/km for all three phases of the FTP. It is of interest to compare the relative amounts of the different hydrocarbons as a function of test temperature. Complete chromatographic data for each test are given in Appendix C. Selected results will be discussed here.

Methane--Table 70 lists the percent methane that was obtained using the cold transient phase of the FTP. The three noncatalyst cars had relatively small methane contents (2.6 to 12.9%) in this high emitting phase of the cycle. The catalyst equipped cars generally had more methane; from 7.4% for the 1977 Ford at 0°F (-18°C) to 36.3% for the 1979 Dodge Aspen at 90°F (32°C) with air conditioning.

TABLE 70 GAS CHROMATOGRAPHIC ANALYSIS

COLD TRANSIENT FTP - METHANE- % BY WT

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	9.7	11.7	8.8	7.2	7.5	2.6	5.2	7.0	6.4	6.7	8.2
	10.8	10.7	10.0	7.3	4.1	2.5	5.1	4.4	4.3	3.5	2.8
AVE	10.3	11.2	9.4	7.2	5.8	2.6	5.1	5.7	5.4	5.1	5.5
1974 CHEVROLET IMPALA	11.9	9.4	6.9	8.8	5.1	5.2	.	3.7	.	3.5	.
	10.4	10.4	13.8	7.6	7.3	3.3	.	4.6	.	3.5	.
	.	.	.	6.4	.	.	.	.	.	.	.
AVE	11.2	9.9	10.4	7.6	6.2	4.3	.	4.1	.	3.5	.
1977 HONDA CIVIC 49 STATE	10.3	8.4	7.1	7.7	8.6	9.2	.	16.2	.	9.3	.
	9.0	10.0	4.6	7.3	7.9	9.2	.	9.6	.	10.0	.
AVE	9.6	9.2	5.8	7.5	8.3	9.2	.	12.9	.	9.6	.
1977 FORD LTD 49 STATE	7.9	7.6	8.1	8.7	8.6	8.1	10.6	10.4	8.7	8.3	9.9
	6.8	7.2	7.9	8.0	7.8	7.3	8.0	8.9	7.0	7.3	8.3
	7.5	.	.	.	.	.	.	.	.	.	.
AVE	7.4	7.4	8.0	8.4	8.2	7.7	9.3	9.7	7.9	7.8	9.1
1977 PLYMOUTH FURY 49S	9.2	14.1	14.1	7.2	14.4	10.2	.	14.9	.	12.7	.
	11.0	9.5	13.0	7.0	11.2	7.2	.	11.5	.	13.5	.
	.	.	.	11.6	15.1	.	.	.	.	.	.
AVE	10.1	11.8	13.6	8.6	13.6	8.7	.	13.2	.	13.1	.
1978 BUICK V6 TURBOCHARGE	7.1	8.3	12.5	10.9	10.5	12.0	13.1	16.2	15.4	13.6	16.7
	8.4	8.7	7.7	11.6	11.5	12.0	15.4	11.0	14.2	13.0	17.8
	8.8	.	.	.	.	.	.	.	.	.	.
AVE	8.1	8.5	10.1	11.3	11.0	12.0	14.2	13.6	14.8	13.3	17.2
1977 PLYMOUTH FURY CALIF	11.3	13.2	17.2	13.9	15.7	23.9	21.0	23.2	22.7	27.9	20.7
	13.4	19.1	21.7	13.6	11.7	24.4	18.1	16.9	20.9	12.1	21.6
	.	.	.	.	.	.	.	.	.	.	15.0
AVE	12.4	16.2	19.4	13.8	13.7	24.1	19.6	16.7	21.8	20.0	19.1
1978 CHEVROLET ST W-CALIF	7.1	9.6	14.8	14.0	11.7	14.7	13.2	11.3	10.1	9.3	15.5
	9.0	9.4	15.0	9.4	12.7	12.2	13.8	8.1	11.3	12.4	14.8
AVE	8.1	9.5	14.9	11.7	12.2	13.4	13.5	9.7	10.7	10.8	15.1
1978 FORD PINTO CAL 3 WAY	11.1	15.2	17.8	23.7	18.3	13.2	17.9	21.5	26.8	7.1	24.5
	10.5	11.3	16.2	15.9	19.8	30.2	17.3	19.4	28.1	20.6	19.2
	9.9	.	.	.	.	.	.	30.4	.	.	24.8
AVE	10.5	13.3	17.0	19.8	19.2	21.7	17.6	23.7	27.4	13.9	22.8
1978 VW RABBIT CAL FU-INJ	8.7	11.6	11.5	15.1	12.0	12.0	.	13.4	.	9.7	.
	10.0	11.4	11.5	11.8	11.8	10.9	.	10.7	.	10.1	.
AVE	9.4	11.5	11.5	13.4	11.9	11.5	.	12.0	.	9.9	.
1979 DODGE ASPEN CALIF.	11.2	13.0	13.6	21.2	31.7	34.1	26.5	29.4	39.6	35.8	34.2
	14.1	19.6	16.6	14.8	11.3	13.2	16.6	28.1	32.9	31.2	35.0
AVE	12.7	16.3	15.1	18.0	21.5	23.6	21.5	28.7	36.3	33.5	34.6
1980 MERCURY PROTOTYPE	.	14.9	14.5	17.7	28.9	22.6	20.3	15.8	14.0	9.6	15.1
	.	15.9	.	.	21.6	26.7	.	.	.	9.7	14.3
AVE	.	15.4	14.5	17.7	25.2	24.6	20.3	15.8	14.0	9.7	14.7
1980 BUICK REGAL PROTOTYP	.	13.7	11.4	18.7	13.1	12.1	9.9	12.1	13.3	11.7	12.8
	.	14.1	.	.	11.2	11.2	.	.	.	15.4	14.6
AVE	.	13.9	11.4	18.7	12.2	11.6	9.9	12.1	13.3	13.6	13.7
DATSUN PROTOTYPE	7.8	8.2	11.5	12.2	10.0	12.9	.	12.9	.	10.1	.
	8.0	8.6	10.7	11.3	11.1	13.3	.	12.8	.	14.1	.
	.	.	11.3	.	.	.	.	.	.	.	.
AVE	7.9	8.4	11.2	11.8	10.5	13.1	.	12.8	.	12.1	.

Table 71 compares the methane percentage for the stabilized phase of the FTP. This phase of the FTP had the lowest total hydrocarbons (Table 17). Except for the Honda, with about 10% methane, the noncatalyst cars had only small percentages of methane. The catalyst cars, which generally had very low total hydrocarbons in this phase had quite large fractions of methane. Above 80°F (27°C) the percentage of methane varied from 10.9% for the 1977 Ford to 75% for the 1978 Buick. Clearly, the small amount of hydrocarbons present in this phase has a very high portion present as methane.

TABLE 71 GAS CHROMATOGRAPHIC ANALYSIS

	STABILIZED FTP - METHANE - % BY WT										
TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	3.7	4.4	3.7	6.2	7.0	5.0	3.8	9.0	7.9	11.2	11.1
	1.9	5.8	9.0	5.4	2.6	1.6	4.4	5.0	4.6	5.5	2.8
AVE	4.1	5.1	6.4	5.8	4.8	3.3	4.1	7.0	6.3	8.3	7.0
1974 CHEVROLET IMPALA	4.3	1.5	2.6	2.8	3.1	3.6	.	4.1	.	3.2	.
	4.1	3.0	2.8	2.6	2.1	3.0	.	4.0	.	5.3	.
	.	.	.	1.6	.	.	.	.	.	.	.
AVE	4.2	2.3	2.7	2.3	2.6	3.3	.	4.0	.	4.3	.
1977 HONDA CIVIC 49 STATE	11.6	8.5	12.3	17.8	10.5	11.5	.	10.5	.	10.5	.
	10.3	11.9	7.1	9.9	12.0	10.7	.	10.0	.	9.7	.
AVE	11.0	10.2	9.7	13.9	11.2	11.1	.	10.2	.	10.1	.
1977 FORD LTD 49 STATE	10.0	16.3	15.5	16.6	15.9	16.7	16.2	16.6	11.0	10.9	11.2
	9.7	11.5	11.5	16.3	16.1	17.7	16.3	15.8	13.5	10.9	10.8
	9.1	.	.	.	.	.	.	.	.	.	.
AVE	9.6	13.9	13.5	16.5	16.0	17.2	16.3	16.2	12.2	10.9	11.0
1977 PLYMOUTH FURY 49S	14.1	23.0	36.1	24.7	30.3	31.9	.	37.2	.	20.2	.
	19.1	15.0	16.8	25.1	19.7	34.7	.	34.7	.	24.3	.
	.	.	.	26.3	35.5	.	.	.	.	.	.
AVE	16.6	19.0	26.4	25.3	28.5	33.3	.	36.0	.	22.3	.
1978 BUICK V6 TURBOCHARGE	31.4	29.3	38.1	61.7	59.2	70.3	67.0	65.1	68.1	76.1	75.6
	25.0	42.6	35.9	59.8	47.3	64.7	39.6	43.4	58.2	74.0	74.2
	24.1	.	.	.	.	.	.	.	.	.	.
AVE	26.8	35.9	37.0	60.7	53.2	67.5	53.3	54.3	63.1	75.1	74.9
1977 PLYMOUTH FURY CALIF	32.3	30.7	32.1	35.6	40.3	49.7	35.4	38.3	36.0	21.6	38.9
	37.4	57.3	53.0	24.0	31.4	56.8	24.6	49.3	21.6	31.8	41.8
	.	.	.	.	.	.	.	.	.	.	40.5
AVE	34.8	44.0	42.6	29.8	35.9	53.2	30.0	49.3	28.8	26.7	40.4
1978 CHEVROLET ST W-CALIF	33.4	52.0	27.8	35.8	38.5	39.2	53.4	53.0	61.5	63.4	57.8
	22.2	18.5	22.6	15.6	35.5	27.6	38.3	5.7	47.2	53.8	60.4
AVE	27.8	35.3	25.2	25.7	37.0	33.4	45.9	29.4	54.3	58.6	59.1
1978 FORD PINTO CAL 3 WAY	11.0	25.6	34.5	43.6	43.5	31.8	33.3	40.4	51.3	42.6	54.1
	18.2	19.7	24.5	41.1	33.4	34.4	40.8	45.7	57.8	28.9	56.8
	19.0	.	.	.	.	.	.	52.5	.	.	38.4
AVE	16.1	22.6	29.5	42.4	38.4	33.1	37.1	46.2	54.5	35.8	49.8
1978 VW RABBIT CAL FU-INJ	31.5	47.1	42.2	44.6	35.9	30.5	.	29.9	.	11.8	.
	17.8	50.9	57.0	47.8	35.8	28.0	.	16.2	.	16.4	.
AVE	24.6	49.0	49.6	46.2	35.8	29.2	.	23.1	.	14.1	.
1979 DODGE ASPEN CALIF.	50.2	56.6	50.6	47.1	37.6	54.6	44.1	51.8	45.2	48.3	55.8
	55.5	39.8	41.6	45.0	53.2	54.7	56.5	53.4	52.8	49.9	59.8
AVE	52.8	48.2	46.1	46.0	45.4	54.7	50.3	52.6	49.0	49.1	57.8
1980 MERCURY PROTOTYPE	.	45.7	52.2	60.6	19.4	62.4	44.9	41.2	47.8	52.8	54.7
	.	41.1	.	.	64.3	57.2	.	.	.	45.9	48.5
AVE	.	43.4	52.2	60.6	41.8	59.8	44.9	41.2	47.8	49.3	51.6
1980 BUICK REGAL PROTOTYP	.	38.3	32.0	61.9	61.6	60.5	77.1	46.6	60.2	52.5	37.7
	.	34.6	.	.	62.8	65.5	.	.	.	70.5	31.5
AVE	.	36.4	32.0	61.9	62.2	63.0	77.1	46.6	60.2	61.5	34.6
DATSUN PROTOTYPE	45.2	43.9	35.5	45.9	43.7	52.7	.	49.5	.	49.7	.
	39.7	41.6	46.1	51.2	55.0	51.0	.	60.2	.	42.5	.
	.	.	22.2	.	.	.	.	.	.	.	.
AVE	42.4	42.8	34.6	48.5	49.3	51.9	.	54.9	.	46.1	.

Table 72 gives the methane percentages for the hot transient phase of the FTP. The noncatalyst cars continued to produce low concentrations of methane. The catalyst cars generally produced much larger percentages of methane. The 1977 Ford was an exception and, as previously discussed, may have had a deteriorated catalyst.

TABLE 72 GAS CHROMATOGRAPHIC ANALYSIS

HOT TRANSIENT FTP -METHANE- % BY WT

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	6.0	3.3	3.4	5.0	5.6	4.9	3.9	5.3	6.5	8.4	8.8
	3.5	1.6	2.7	2.7	2.1	1.6	4.7	4.7	4.4	4.8	3.8
AVE	4.7	2.5	3.1	3.8	3.9	3.3	4.3	5.0	5.5	6.6	6.3
1974 CHEVROLET IMPALA	4.1	2.3	2.6	3.0	2.7	2.8	.	2.7	.	5.2	.
	3.4	2.7	2.7	2.4	2.5	2.0	.	2.3	.	4.1	.
	.	.	.	2.4	.	.	.	.	.	.	.
AVE	3.8	2.5	2.6	2.6	2.6	2.4	.	2.5	.	4.7	.
1977 HONDA CIVIC 49 STATE	13.1	13.1	9.8	10.5	9.6	9.2	.	9.0	.	9.3	.
	13.0	10.7	10.0	9.3	9.5	9.4	.	9.5	.	8.7	.
AVE	13.1	11.9	9.9	9.9	9.6	9.3	.	9.3	.	9.0	.
1977 FORD LTD 49 STATE	10.5	12.6	9.5	8.9	9.0	9.0	8.5	7.2	7.0	9.0	7.8
	9.4	8.1	9.6	8.7	9.8	7.9	6.5	7.7	6.9	6.5	9.4
	7.5	.	.	.	.	.	.	.	.	.	.
AVE	9.1	10.4	9.5	8.8	9.4	8.4	7.5	7.5	6.9	7.8	8.6
1977 PLYMOUTH FURY 49S	10.6	14.6	13.4	12.7	12.8	10.5	.	11.5	.	12.5	.
	14.9	12.6	14.4	14.0	14.6	14.0	.	13.2	.	13.5	.
	.	.	.	9.1	15.2	.	.	.	.	.	.
AVE	12.8	13.6	13.9	11.9	14.2	12.2	.	12.3	.	13.0	.
1978 BUICK V6 TURBOCHARGE	14.1	15.4	25.9	36.2	31.3	34.1	30.9	31.6	34.1	35.7	28.1
	5.2	21.3	31.3	30.2	27.5	23.4	32.7	19.9	31.5	36.6	34.7
	5.3	.	.	.	.	.	.	.	.	.	.
AVE	8.2	18.3	28.6	33.2	29.4	28.8	31.8	25.7	32.8	36.1	31.4
1977 PLYMOUTH FURY CALIF	5.7	17.1	0.0	12.1	11.4	11.2	10.4	23.1	18.7	12.6	15.4
	16.5	33.7	32.3	13.4	18.1	13.2	12.7	10.3	22.6	20.3	15.8
	.	.	.	.	.	.	.	.	.	.	18.6
AVE	11.1	25.4	16.1	12.8	14.8	12.2	11.5	16.7	20.7	16.4	16.6
1978 CHEVROLET ST W-CALIF	17.5	12.9	6.0	47.9	24.0	22.6	33.8	29.2	45.8	36.5	37.1
	15.6	11.2	12.7	17.8	21.3	19.4	21.9	15.4	46.6	39.7	46.4
AVE	16.5	12.0	9.3	32.9	22.7	21.0	27.8	22.3	46.2	38.1	41.8
1978 FORD PINTO CAL 3 WAY	26.6	28.1	23.7	35.7	33.6	26.3	33.3	42.7	46.8	34.1	42.3
	24.9	18.9	20.5	22.5	17.5	32.0	38.0	40.9	41.5	25.0	45.0
	29.4	.	.	.	.	.	.	46.4	.	.	31.7
AVE	26.9	23.5	22.1	29.1	25.6	29.2	35.7	43.3	44.1	29.6	39.7
1979 VW RABBIT CAL FU-INJ	18.1	20.0	19.6	23.1	16.6	14.6	.	14.7	.	9.6	.
	18.4	21.4	20.8	18.5	16.3	13.1	.	11.0	.	10.6	.
AVE	18.2	20.7	20.2	20.8	16.4	13.8	.	12.8	.	10.1	.
1979 DODGE ASPEN CALIF.	43.0	66.1	33.5	33.9	27.8	29.8	27.0	30.7	42.8	38.5	38.2
	39.0	24.3	22.3	24.8	36.0	32.4	32.1	34.7	32.6	36.2	37.7
AVE	41.0	45.2	27.9	29.3	31.9	31.1	29.6	32.7	37.7	37.4	37.9
1980 MERCURY PROTOTYPE	.	16.9	18.1	21.9	23.5	5.9	25.3	18.6	17.7	13.5	24.5
	.	15.3	.	.	40.2	20.2	.	.	.	28.0	23.0
AVE	.	16.1	18.1	21.9	31.9	13.1	25.3	18.6	17.7	20.8	23.8
1980 BUICK REGAL PROTOTYPE	.	18.9	17.7	24.8	26.5	29.1	38.4	27.9	31.1	18.5	21.1
	.	13.4	.	.	23.7	28.2	.	.	.	25.3	16.9
AVE	.	16.2	17.7	24.8	25.1	28.6	38.4	27.9	31.1	21.9	19.0
DATSUN PROTOTYPE	25.5	23.9	21.6	22.2	22.5	30.1	.	32.2	.	25.3	.
	19.6	22.3	22.9	26.7	30.7	30.5	.	39.1	.	30.9	.
	.	.	20.7	.	.	.	.	.	.	.	.
AVE	22.5	23.1	21.7	24.5	26.6	30.3	.	35.7	.	28.1	.

Saturates--Of the remaining nonmethane hydrocarbons, a very large fraction was saturates. Data in Table 73 show that whether the car had a catalyst or not, the saturates (excluding methane) accounted for 23.3 to 53.6% of the total hydrocarbons for the cold transient phase of the FTP. Saturates were a major component of the test fuel.

TABLE 73 GAS CHROMATOGRAPHIC ANALYSIS

COLD TRANSIENT FTP - SATURATES- % BY WT

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	42.3	33.9	35.9	36.0	33.4	54.4	25.5	35.9	36.3	39.1	35.6
	40.1	34.3	33.9	34.1	43.6	50.4	38.3	37.1	38.0	45.5	39.0
AVE	41.2	34.1	34.9	35.0	38.5	52.4	31.9	36.5	37.1	42.3	37.3
1974 CHEVROLET IMPALA	36.7	44.9	41.9	37.0	46.1	49.9	.	48.1	.	50.1	.
	43.7	41.8	34.7	38.9	43.0	48.8	.	45.4	.	51.1	.
	.	.	.	42.9	.	.	.	.	.	.	.
AVE	40.2	43.4	38.3	39.6	44.5	49.3	.	46.8	.	50.6	.
1977 HONDA CIVIC 49 STATE	38.8	44.0	40.4	34.5	30.8	27.1	.	21.4	.	24.2	.
	41.8	38.9	49.6	35.7	29.9	27.2	.	23.3	.	24.5	.
AVE	40.3	41.4	45.0	35.1	30.3	27.2	.	22.3	.	24.4	.
1977 FORD LTD 49 STATE	48.3	48.2	47.8	39.5	40.2	41.1	41.1	34.2	38.8	39.9	35.9
	50.2	48.9	49.0	41.9	42.5	42.8	43.4	39.0	34.9	38.1	39.2
	47.2	.	.	.	.	.	.	.	.	.	.
AVE	48.6	48.5	48.4	40.7	41.3	41.9	42.2	36.6	36.8	39.0	37.6
1977 PLYMOUTH FURY 49S	42.2	38.1	36.3	36.7	31.8	40.1	.	29.6	.	34.2	.
	43.9	48.9	40.9	48.9	32.2	42.0	.	34.3	.	30.8	.
	.	.	.	33.1	27.1	.	.	.	.	.	.
AVE	43.0	43.5	38.6	39.6	30.4	41.0	.	31.9	.	32.5	.
1978 BUICK V6 TURBOCHARGE	44.1	42.3	41.1	36.7	38.5	36.3	33.8	35.7	36.7	38.8	32.0
	43.4	40.7	45.4	36.8	35.9	34.6	32.0	39.0	33.3	37.5	31.9
	43.1	.	.	.	.	.	.	.	.	.	.
AVE	43.5	41.5	43.3	36.8	37.2	35.5	32.9	37.3	35.0	38.1	31.9
1977 PLYMOUTH FURY CALIF	45.3	45.2	39.8	41.8	51.0	47.2	38.1	36.6	35.3	35.1	35.8
	47.2	38.9	37.3	49.2	46.4	35.9	43.3	48.2	32.3	46.8	37.6
	.	.	.	.	.	.	.	.	.	.	39.4
AVE	46.3	42.0	38.5	45.5	48.7	41.5	40.7	42.4	33.8	40.9	37.6
1978 CHEVROLET ST W-CALIF	61.4	46.7	44.0	40.4	36.6	43.2	43.9	48.0	46.4	52.4	34.8
	49.0	47.6	40.5	41.3	39.9	45.3	42.9	49.3	42.8	46.0	39.8
AVE	55.2	47.2	42.3	40.9	38.2	44.3	43.4	48.7	44.6	49.2	37.3
1978 FORD PINTO CAL 3 WAY	48.8	40.4	35.0	31.5	42.3	48.2	43.3	46.6	39.2	47.8	43.2
	44.3	47.5	39.2	43.2	39.4	37.6	43.2	46.8	38.2	44.3	45.6
	48.3	.	.	.	.	.	.	46.7	.	.	38.1
AVE	47.1	43.9	37.1	37.3	40.8	42.9	43.2	46.7	38.7	46.0	42.2
1978 VW RABBIT CAL FU-INJ	40.0	38.1	37.1	38.9	38.3	37.3	.	37.3	.	34.7	.
	38.2	37.6	39.6	36.4	35.6	38.1	.	34.4	.	32.7	.
AVE	39.1	37.8	38.4	37.7	37.0	37.7	.	35.8	.	33.7	.
1979 DODGE ASPEN CALIF.	41.3	39.7	35.3	34.4	33.6	35.3	34.5	30.9	32.9	29.6	27.8
	39.9	34.0	35.7	41.8	46.2	42.7	38.9	32.6	32.7	31.5	29.2
AVE	40.6	36.8	35.5	38.1	39.9	39.0	36.7	31.8	32.8	30.5	28.5
1980 MERCURY PROTOTYPE	.	30.5	33.3	46.0	49.9	51.3	52.8	53.5	53.6	54.9	49.6
	.	35.5	.	.	51.8	48.9	.	.	.	51.6	53.5
AVE	.	33.0	33.3	46.0	50.9	50.1	52.8	53.5	53.6	53.3	51.5
1980 BUICK REGAL PROTOTYP	.	30.9	35.3	51.8	31.4	36.5	39.9	39.6	33.3	35.9	36.6
	.	29.3	.	.	35.6	37.9	.	.	.	32.8	36.5
AVE	.	29.9	35.3	51.8	33.5	37.2	39.9	39.6	33.3	34.4	36.6
DATSUN PROTOTYPE	49.7	52.6	43.3	39.2	31.6	43.1	.	41.0	.	38.3	.
	52.7	50.6	46.2	46.7	44.6	44.1	.	33.4	.	44.1	.
	.	.	47.9	.	.	.	.	.	.	.	.
AVE	51.2	51.6	45.8	42.9	38.1	43.6	.	37.2	.	41.2	.

The stabilized FTP results which are presented in Table 74 show a similar trend. It is of particular interest to compare Tables 71 and 74. The sum of the methane and saturates frequently totaled over 90% at the higher temperatures, particularly for the prototype cars. Since the total hydrocarbon emissions were low in this test phase, there was little reactive material present in the remaining hydrocarbons.

TABLE 74 GAS CHROMATOGRAPHIC ANALYSIS

STABILIZED FTP - SATURATES- % BY WT

TEMPERATURE F	0 (C)(-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	24.2	27.6	27.4	28.1	28.2	40.0	18.5	28.4	24.3	27.5	27.3
	47.8	24.0	35.5	25.5	38.1	50.3	20.3	27.4	28.9	37.5	35.7
AVE	36.0	25.8	27.6	26.8	33.2	45.1	19.4	27.9	26.6	32.5	31.5
1974 CHEVROLET IMPALA	33.4	44.8	49.3	34.6	43.4	47.2	.	47.1	.	52.2	
	30.1	37.8	47.3	49.2	54.6	44.8	.	43.1	.	40.6	.
	.	.	.	52.2	.	.	.	.	.	.	.
AVE	31.8	41.3	48.3	45.3	49.0	46.0	.	45.1	.	46.4	.
1977 HONDA CIVIC 49 STATE	30.1	37.7	17.4	13.5	12.4	15.8	.	17.2	.	19.6	
	31.5	33.9	12.5	15.2	14.9	15.0	.	16.1	.	19.5	.
AVE	30.8	35.8	14.5	14.3	13.7	15.4	.	16.6	.	19.6	.
1977 FORD LTD 49 STATE	43.9	50.3	56.4	40.3	39.7	50.4	36.1	39.9	38.7	39.4	37.8
	41.4	45.1	41.8	38.6	37.3	40.4	35.0	34.6	35.9	36.2	37.6
	45.0	.	.	.	.	.	.	.	.	.	.
AVE	43.4	48.1	49.1	39.5	38.5	45.4	35.6	37.2	37.3	37.8	37.7
1977 PLYMOUTH FURY 49S	31.6	40.9	40.5	42.5	32.6	42.6	.	37.9	.	26.8	
	35.5	35.9	35.7	39.4	31.1	36.0	.	36.4	.	27.0	.
	.	.	.	35.9	29.9	.	.	.	.	.	.
AVE	33.6	38.4	38.3	39.2	34.6	39.3	.	37.2	.	26.9	.
1974 BUICK V6 TURBOCHARGE	32.1	44.4	42.0	35.0	29.2	32.6	31.9	38.4	31.1	24.5	21.3
	35.4	29.4	18.6	40.1	33.8	34.3	30.4	48.3	37.6	23.0	24.0
	41.1	.	.	.	.	.	.	.	.	.	.
AVE	36.2	36.9	30.3	37.6	31.0	33.5	31.2	43.3	34.4	23.7	22.6
1977 PLYMOUTH FURY CALIF	38.7	53.7	48.8	46.5	36.9	42.4	54.1	63.6	42.8	65.1	24.6
	33.5	38.1	34.4	65.6	52.1	38.1	66.8	37.9	68.4	46.0	35.6
	.	.	.	.	.	.	.	.	.	.	37.5
AVE	36.1	45.9	41.6	56.0	44.4	40.3	60.4	37.9	55.6	55.6	32.6
1978 CHEVROLET ST W-CALIF	49.5	46.6	65.9	50.1	47.7	54.4	42.3	44.9	33.4	50.7	26.9
	53.5	65.1	54.1	72.7	57.1	59.5	51.0	84.7	41.4	45.0	28.2
AVE	51.5	55.9	60.0	61.4	52.4	57.0	46.7	64.8	37.4	47.9	27.5
1978 FORD PINTO CAL 3 WAY	29.8	58.1	49.1	47.2	51.6	55.9	53.8	54.3	46.9	52.0	41.7
	39.2	42.0	50.0	52.9	56.7	58.7	54.2	53.7	42.8	55.9	40.5
	44.2	.	.	.	.	.	.	49.2	.	.	51.3
AVE	37.7	50.0	49.6	50.0	54.2	57.3	54.0	52.4	44.8	53.9	44.5
1978 VW RABBIT CAL FU-INJ	27.1	24.1	33.6	26.9	30.9	35.3	.	33.9	.	32.5	.
	27.3	27.9	27.0	30.7	35.1	34.9	.	34.3	.	33.2	.
AVE	27.2	26.0	30.3	28.8	33.0	35.1	.	34.1	.	32.8	.
1979 DODGE ASPEN CALIF.	41.1	35.0	44.9	49.4	36.6	42.2	36.5	45.4	37.3	44.9	32.0
	36.6	49.7	45.5	45.9	42.0	39.6	39.7	41.2	44.7	41.2	36.7
AVE	38.9	42.4	45.1	47.7	39.3	40.9	38.1	43.3	41.0	43.1	34.3
1980 MERCURY PROTOTYPE	.	35.9	37.1	42.3	68.8	40.1	41.1	53.6	43.2	44.1	45.0
	.	36.2	.	.	37.1	41.8	.	.	.	45.7	47.9
AVE	.	36.1	37.1	42.3	52.9	41.3	41.1	53.6	43.2	44.9	46.4
1980 BUICK REGAL PROTOTYP	.	41.5	30.9	30.4	39.6	40.8	26.2	49.6	32.3	41.8	48.8
	.	46.1	.	.	42.7	34.5	.	.	.	31.6	51.5
AVE	.	43.8	30.9	30.4	41.1	37.7	26.2	49.6	32.3	36.7	50.1
DATSUN PROTOTYPE	56.6	54.5	61.7	51.0	38.5	48.0	.	41.2	.	42.4	.
	59.2	57.8	55.0	44.0	45.1	44.8	.	39.7	.	36.7	.
	.	.	35.5	.	.	.	.	.	.	.	.
AVE	57.9	56.2	50.8	47.5	41.8	46.4	.	40.4	.	39.5	.

Table 75 shows the percent of saturates in the hydrocarbon emissions obtained during the hot transient phase of the FTP. Again, a very high fraction of saturates was found for all vehicles. This reflects the nature of the gasoline.

TABLE 75 GAS CHROMATOGRAPHIC ANALYSIS

HOT TRANSIENT FTP -SATURATES- % BY WT

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	40.0	35.7	42.1	37.5	34.5	35.2	39.3	42.3	34.5	36.3	35.9
	49.3	40.5	33.0	39.9	44.2	49.9	36.3	35.5	33.3	44.5	48.0
AVE	44.6	38.1	37.5	38.7	39.3	42.1	37.8	38.9	33.9	40.4	41.9
1974 CHEVROLET IMPALA	46.1	52.1	54.4	48.7	55.1	58.2	.	57.8	.	52.8	.
	46.8	52.3	54.5	53.2	49.3	56.5	.	58.2	.	54.2	.
	.	.	.	49.7	.	.	.	.	.	.	.
AVE	46.5	52.2	54.4	50.5	52.2	57.3	.	58.0	.	53.5	.
1977 HONDA CIVIC 49 STATE	19.9	18.2	26.3	24.2	24.3	27.2	.	28.2	.	28.8	.
	20.5	22.6	25.9	23.7	26.8	23.4	.	23.5	.	27.2	.
AVE	20.2	20.4	26.1	23.9	25.5	25.3	.	25.9	.	28.0	.
1977 FORD LTD 49 STATE	48.9	49.1	55.7	50.9	52.6	50.9	46.9	50.6	42.8	45.2	48.1
	44.9	49.3	50.0	46.3	46.0	49.0	50.9	50.0	48.0	47.3	42.2
	50.8	.	.	.	.	.	.	.	.	.	.
AVE	48.2	49.2	52.8	48.6	49.3	49.9	48.9	50.3	45.4	46.3	45.1
1977 PLYMOUTH FURY 49S	40.0	45.4	40.3	45.4	43.5	49.3	.	49.2	.	39.0	.
	45.2	40.4	40.4	35.1	36.9	50.1	.	42.3	.	29.9	.
	.	.	.	35.2	39.6	.	.	.	.	.	.
AVE	42.6	42.9	40.3	38.5	40.0	49.7	.	45.8	.	34.5	.
1978 BUICK V6 TURBOCHARGE	44.8	45.4	48.9	44.0	44.6	50.3	48.0	46.7	42.9	39.6	40.9
	49.8	47.7	39.1	47.1	49.5	42.2	43.8	52.7	42.8	38.6	38.0
	52.2	.	.	.	.	.	.	.	.	.	.
AVE	48.9	46.5	44.0	45.5	47.0	46.3	45.9	49.7	42.8	39.1	39.4
1977 PLYMOUTH FURY CALIF	30.0	58.5	68.8	46.7	60.1	58.4	57.4	46.7	52.1	59.1	55.5
	57.7	46.4	46.1	52.0	52.8	53.6	57.8	30.1	42.3	42.9	51.6
	.	.	.	.	.	.	.	.	.	.	48.4
AVE	43.8	52.4	57.4	49.3	56.5	56.0	57.6	38.4	47.2	51.0	51.8
1978 CHEVROLET ST W-CALIF	56.0	63.0	81.2	32.5	60.4	59.6	51.0	57.0	41.8	49.4	43.0
	66.2	70.2	64.2	68.3	62.3	60.8	58.8	58.3	35.6	45.6	32.4
AVE	61.1	66.6	72.7	50.4	61.4	60.2	54.9	57.7	38.7	47.5	37.7
1978 FORD PINTO CAL 3 WAY	54.2	59.4	53.9	53.1	52.0	51.7	49.3	50.3	45.6	55.2	43.7
	43.8	48.7	54.8	66.0	68.2	57.1	51.0	51.3	52.5	53.6	44.5
	60.1	.	.	.	.	.	.	51.3	.	.	53.5
AVE	52.7	54.1	54.4	59.5	60.1	54.4	50.2	51.0	49.0	54.4	47.2
1978 VW RABBIT CAL FU-INJ	44.9	42.8	42.1	45.6	41.3	51.9	.	40.1	.	36.7	.
	39.4	46.7	46.7	40.1	39.3	36.2	.	36.8	.	34.5	.
AVE	42.2	44.8	44.4	42.9	40.3	44.1	.	38.5	.	35.6	.
1979 DODGE ASPEN CALIF.	46.5	26.6	51.0	49.2	55.8	50.9	56.2	52.6	39.3	40.9	40.0
	50.4	55.3	55.6	50.1	42.9	48.0	48.2	45.6	45.9	41.6	42.3
AVE	48.5	41.0	53.3	49.7	49.3	49.4	52.2	49.1	42.6	41.3	41.1
1980 MERCURY PROTOTYPE	.	51.2	55.9	49.1	51.2	55.5	48.9	55.7	59.6	53.3	53.1
	.	60.0	.	.	41.3	52.3	.	.	.	44.9	46.5
AVE	.	55.6	55.9	49.1	46.3	53.9	48.9	55.7	59.6	49.1	49.8
1980 BUICK REGAL PROTOTYP	.	48.3	50.9	50.5	45.4	52.9	43.9	57.3	47.7	50.0	44.1
	.	56.7	.	.	51.1	50.1	.	.	.	50.8	44.1
AVE	.	52.5	50.9	50.5	48.2	51.5	43.9	57.3	47.7	50.4	44.1
DATSUN PROTOTYPE	56.8	63.2	68.4	64.6	53.7	58.1	.	55.4	.	60.0	.
	58.1	66.0	65.3	59.1	60.0	56.5	.	52.0	.	52.8	.
	.	.	70.2	.	.	.	.	.	.	.	.
AVE	57.5	64.6	68.0	61.9	56.8	57.3	.	53.7	.	56.4	.

Acetylene--Tables 76-78 present the percent of acetylenic compounds in the hydrocarbons present in the exhaust gases. At one time, acetylene, the principal component in these tables, was thought to be a good tracer for automotive exhaust in the air. This was because non-catalyst cars produced acetylene concentrations which varied from 2 to 14% of the hydrocarbons present in their exhaust gases, as shown in all three tables. However, with the advent of catalysts, the amount of acetylene

TABLE 76 GAS CHROMATOGRAPHIC ANALYSIS

COLD TRANSIENT FTP - ACETYLENE % TOTAL HC

TEMPERATURE F	0	20	40	60	70	80	80AC	90	90AC	110	110AC
(C)	(-18)	(-7)	(4)	(16)	(21)	(27)	(27)	(32)	(32)	(43)	(43)
1972 CHEVROLET IMPALA	11.5	14.9	9.8	8.0	9.1	2.4	5.7	7.0	5.4	6.0	6.8
	13.3	13.6	11.3	8.6	4.7	2.6	5.1	4.2	3.9	3.4	1.7
AVE	12.4	14.2	10.6	8.3	6.9	2.5	5.4	5.6	4.7	4.7	4.3
1974 CHEVROLET IMPALA	12.9	11.5	7.8	9.0	5.2	5.2	.	3.5	.	2.6	.
	11.5	12.3	16.8	6.7	6.6	2.7	.	4.2	.	2.9	.
	.	.	.	6.2	.	.	.	.	.	.	.
AVE	12.2	11.9	12.3	7.3	5.9	3.9	.	3.8	.	2.7	.
1977 HONDA CIVIC 49 STATE	7.4	5.2	6.1	6.1	5.3	6.8	.	7.4	.	6.4	.
	7.0	6.7	4.3	6.0	5.6	7.1	.	6.3	.	6.6	.
AVE	7.2	5.9	5.2	6.1	5.5	6.9	.	6.9	.	6.5	.
1977 FORD LTD 49 STATE	2.5	2.3	2.1	0.7	0.8	0.8	0.9	0.9	0.6	0.9	0.7
	3.1	2.0	2.7	1.0	1.3	1.0	0.7	0.7	0.6	0.5	1.1
	2.9	.	.	.	.	.	.	.	.	.	.
AVE	2.9	2.1	2.4	0.9	1.0	0.9	0.8	0.8	0.6	0.7	0.9
1977 PLYMOUTH FURY 49S	6.7	10.2	9.8	2.7	8.5	1.4	.	5.2	.	3.8	.
	7.3	7.6	11.0	5.3	9.0	2.4	.	4.0	.	3.4	.
	.	.	.	8.1	8.3	.	.	.	.	.	.
AVE	7.0	8.9	10.4	5.4	8.6	1.9	.	4.6	.	3.6	.
1978 BUICK V6 TURBOCHARGE	5.9	7.1	5.2	10.1	8.1	8.4	8.0	8.4	6.0	3.2	3.1
	7.0	7.7	7.1	9.8	9.1	7.7	9.0	6.0	6.8	4.9	4.1
	6.7	.	.	.	.	.	.	.	.	.	.
AVE	6.5	7.4	6.1	10.0	8.6	8.1	8.5	7.2	6.4	4.1	3.6
1977 PLYMOUTH FURY CALIF.	5.1	4.2	3.8	2.9	0.0	0.0	2.3	2.5	3.3	4.0	4.3
	5.2	6.0	5.7	3.5	3.4	3.4	2.6	3.2	4.0	1.7	2.2
	.	.	.	.	.	.	.	.	.	.	4.5
AVE	5.2	5.1	4.7	3.2	1.7	1.7	2.4	2.8	3.7	2.8	3.7
1978 CHEVROLET STA-CALIF	1.2	5.4	6.2	4.9	4.4	3.9	3.0	2.3	1.5	1.2	2.4
	5.7	5.2	6.6	3.4	4.2	2.9	1.7	1.2	1.3	1.6	1.7
AVE	3.5	5.3	6.4	4.1	4.3	3.4	2.4	1.7	1.4	1.4	2.1
1978 FORD PINTO CAL 3 WAY	2.6	2.2	7.7	7.4	8.1	2.3	2.3	1.7	1.3	1.7	0.9
	3.7	3.9	5.4	3.2	3.1	2.8	3.2	1.7	1.6	1.3	1.9
	3.2	.	.	.	.	.	.	1.0	.	.	2.2
AVE	3.2	3.1	6.6	5.3	5.6	2.6	2.7	1.5	1.4	1.5	1.7
1978 VW RABBIT CAL FU-INJ	3.5	3.8	3.4	5.5	4.0	2.9	.	3.2	.	1.3	.
	3.7	3.9	4.2	3.3	3.5	3.3	.	1.9	.	1.3	.
AVE	3.6	3.9	3.8	4.4	3.7	3.1	.	2.5	.	1.3	.
1979 DODGE ASPEN CALIF.	1.2	1.8	1.2	5.9	3.2	2.4	3.5	2.2	1.5	2.0	1.8
	1.6	3.3	3.0	4.8	2.7	3.0	3.1	2.3	1.7	2.4	1.6
AVE	1.4	2.5	2.1	5.3	3.0	2.7	3.3	2.2	1.6	2.2	1.7
1980 MERCURY PROTOTYPE	.	8.1	8.2	2.0	3.1	4.9	2.1	5.2	2.2	2.4	2.4
	.	8.5	.	.	2.6	2.9	.	.	.	2.6	1.5
AVE	.	8.3	8.2	2.0	2.8	3.9	2.1	5.2	2.2	2.5	2.0
1980 BUICK REGAL PROTOTYP	.	4.3	4.6	5.0	2.7	1.9	2.2	2.6	3.3	3.6	1.8
	.	3.9	.	.	2.3	2.5	.	.	.	2.5	2.3
AVE	.	4.1	4.6	5.0	2.5	2.2	2.2	2.6	3.3	3.1	2.1
DATSUN PROTOTYPE	2.3	1.2	0.9	3.9	1.3	1.1	.	1.0	.	0.5	.
	2.2	1.5	1.6	1.2	1.1	0.9	.	0.7	.	0.1	.
	.	.	1.7	.	.	.	.	.	.	.	.
AVE	2.3	1.4	1.4	2.5	1.2	1.0	.	0.9	.	0.3	.

in the exhaust gas has dropped dramatically. This is shown in Tables 77 and 78. Where the time to warm up the catalyst was important, the results presented in Table 76 show that acetylene was still produced, sometimes in large amounts.

TABLE 77 GAS CHROMATOGRAPHIC ANALYSIS

	STABILIZED FTP - ACETYLENE % TOTAL HC										
TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	6.2	4.4	3.6	5.4	6.9	5.1	4.0	7.6	6.4	8.9	8.1
	1.9	5.9	9.1	5.0	2.5	1.5	4.0	4.2	3.8	4.5	2.0
AVE	4.0	5.2	6.4	5.2	4.7	3.3	4.0	5.9	5.1	6.7	5.1
1974 CHEVROLET IMPALA	3.1	1.4	2.3	2.8	3.1	3.3	.	2.7	.	2.0	.
	3.2	2.9	2.3	2.4	1.9	2.9	.	3.1	.	3.3	.
	.	.	.	1.4	.	.	.	.	.	.	.
AVE	3.1	2.1	2.3	2.2	2.5	3.1	.	2.9	.	2.7	.
1977 HONDA CIVIC 49 STATE	7.9	7.2	9.4	9.4	7.0	9.6	.	9.0	.	7.0	.
	6.0	8.4	5.7	7.7	7.8	8.6	.	6.9	.	7.3	.
AVE	7.0	7.8	7.6	8.5	7.4	9.1	.	7.9	.	7.2	.
1977 FORD LTD 49 STATE	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.2	0.5
	0.1	0.5	0.0	0.0	0.1	0.0	0.4	0.4	0.2	0.0	0.3
	0.1	.	.	.	.	.	.	.	.	.	.
AVE	0.1	0.2	0.0	0.0	0.1	0.0	0.2	0.2	0.1	0.1	0.4
1977 PLYMOUTH FURY 49S	1.2	1.0	1.4	0.7	0.9	0.0	.	0.9	.	0.9	.
	0.6	1.2	1.1	1.8	1.0	1.2	.	1.1	.	1.1	.
	.	.	.	1.0	1.0	.	.	.	.	.	.
AVE	0.9	1.1	1.2	1.2	1.0	0.6	.	1.0	.	1.0	.
1978 BUICK V6 TURBOCHARGE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	.	.	.	.	.	.	.	.	.	.
AVE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1977 PLYMOUTH FURY CALIF	0.0	0.0	0.0	0.0	1.9	0.0	0.4	0.0	1.1	0.0	1.6
	4.9	0.0	0.0	0.6	0.4	0.0	0.8	0.0	0.4	0.9	0.5
	.	.	.	.	.	.	.	.	.	.	0.7
AVE	2.4	0.0	0.0	0.3	1.1	0.0	0.6	0.0	0.8	0.5	0.9
1978 CHEVROLET ST W-CALIF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1978 FORD PINTO CAL 3 WAY	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	.	.	.	.	.	.	0.0	.	.	0.0
AVE	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1978 VW RABBIT CAL FU-INJ	0.0	0.0	0.0	0.0	0.0	0.0	.	0.0	.	0.0	.
	1.2	0.0	0.0	0.0	0.0	0.0	.	0.0	.	0.0	.
AVE	0.6	0.0	0.0	0.0	0.0	0.0	.	0.0	.	0.0	.
1979 DODGE ASPEN CALIF.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1980 MERCURY PROTOTYPE	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	.	0.0	.	.	0.0	0.0	.	.	.	0.0	0.0
AVE	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1980 BUICK REGAL PROTOTYP	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	.	0.0	.	.	0.0	0.0	.	.	.	0.0	0.0
AVE	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DATSUN PROTOTYPE	0.0	0.0	0.0	0.0	0.0	0.0	.	0.0	.	0.0	.
	0.0	0.0	0.0	0.0	0.0	0.0	.	0.0	.	0.0	.
	.	.	0.0	.	.	.	.	.	.	.	.
AVE	0.0	0.0	0.0	0.0	0.0	0.0	.	0.0	.	0.0	.

TABLE 78 GAS CHROMATOGRAPHIC ANALYSIS

HOT TRANSIENT FTP -ACETYLENE % TOTAL HC

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	6.2	4.0	3.6	4.9	6.1	5.5	4.1	4.6	5.6	7.0	7.4
	4.0	1.8	2.9	2.8	2.3	1.6	4.4	4.2	3.9	4.1	3.1
AVE	5.1	2.9	3.2	3.9	4.2	3.5	4.2	4.4	4.8	5.6	5.2
1974 CHEVROLET IMPALA	2.8	2.1	2.3	2.6	2.1	2.4	•	1.8	•	3.1	•
	2.6	2.3	2.2	2.2	2.0	1.6	•	1.6	•	2.3	•
	•	•	•	1.9	•	•	•	•	•	•	•
AVE	2.7	2.2	2.2	2.2	2.0	2.0	•	1.7	•	2.7	•
1977 HONDA CIVIC 49 STATE	7.4	8.5	6.6	7.0	6.7	5.5	•	5.8	•	5.3	•
	8.3	7.2	6.7	6.7	5.9	6.3	•	5.9	•	5.4	•
AVE	7.8	7.9	6.7	6.9	6.3	5.9	•	5.8	•	5.4	•
1977 FORD LTD 49 STATE	0.3	0.4	0.4	0.4	0.3	0.8	0.3	0.3	0.3	0.4	1.5
	0.4	0.3	0.5	0.3	0.6	0.3	0.3	0.3	0.2	0.2	0.8
	0.3	•	•	•	•	•	•	•	•	•	•
AVE	0.3	0.3	0.4	0.4	0.5	0.5	0.3	0.3	0.3	0.3	1.2
1977 PLYMOUTH FURY 495	2.4	1.3	1.5	1.3	1.6	1.6	•	1.3	•	2.5	•
	1.4	2.2	1.9	2.1	3.0	0.8	•	1.6	•	3.8	•
	•	•	•	6.1	1.6	•	•	•	•	•	•
AVE	1.9	1.7	1.7	3.1	2.1	1.2	•	1.5	•	3.1	•
1978 BUICK V6 TURBOCHARGE	4.6	0.6	0.4	0.0	0.0	0.0	0.0	0.9	0.2	1.4	1.7
	1.4	0.2	0.6	0.1	0.4	3.1	1.0	0.2	1.3	0.7	0.8
	2.4	•	•	•	•	•	•	•	•	•	•
AVE	2.8	0.4	0.5	0.1	0.2	1.6	0.5	0.5	0.7	1.0	1.2
1977 PLYMOUTH FURY CALIF	0.5	0.9	1.4	0.8	0.0	0.0	1.2	1.2	0.9	0.5	0.8
	1.8	2.0	1.9	0.7	0.9	2.0	1.1	0.5	1.4	1.3	0.7
	•	•	•	•	•	•	•	•	•	•	1.2
AVE	1.1	1.4	1.6	0.8	0.5	1.0	1.1	0.5	1.2	0.9	0.9
1978 CHEVROLET ST W-CALIF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0
	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
AVE	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.0
1978 FORD PINTO CAL 3 WAY	0.0	0.0	0.6	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	•	•	•	•	•	•	0.0	•	•	0.0
AVE	0.0	0.0	0.3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
1978 VW RABBIT CAL FU-INJ	0.0	0.0	0.0	0.0	0.0	0.0	•	0.0	•	0.6	•
	0.0	0.0	0.0	0.0	0.0	0.0	•	0.1	•	1.0	•
AVE	0.0	0.0	0.0	0.0	0.0	0.0	•	0.1	•	0.8	•
1979 DODGE ASPEN CALIF.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1980 MERCURY PROTOTYPE	•	0.0	0.4	0.0	0.3	0.2	0.2	0.1	0.2	0.1	0.0
	•	0.0	•	•	0.0	0.0	•	•	•	0.3	0.0
AVE	•	0.0	0.4	0.0	0.1	0.1	0.2	0.1	0.2	0.2	0.0
1980 BUICK REGAL PROTOTYP	•	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	•	0.0	•	•	0.0	0.0	•	•	•	0.0	0.0
AVE	•	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DATSUN PROTOTYPE	0.0	0.0	0.0	0.0	0.0	0.0	•	0.0	•	0.0	•
	0.0	0.0	0.0	0.0	0.0	0.0	•	0.0	•	0.0	•
	•	•	0.0	•	•	•	•	•	•	•	•
AVE	0.0	0.0	0.0	0.0	0.0	0.0	•	0.0	•	0.0	•

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Olefins--Olefin data for the three phases of the FTP are given in Tables 79-81. The noncatalyst cars had exhaust gas with typical olefin fractions which varied from 13 to 48%. Except for the 1977 Ford, 1977 (49 State) Plymouth and 1978 VW, the catalyst cars generally produced much lower olefin levels, particularly in the stabilized phase of testing.

TABLE 79 GAS CHROMATOGRAPHIC ANALYSIS

COLD TRANSIENT FTP - OLEFINS- % BY WT

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	20.4	19.0	15.8	24.0	28.2	25.8	20.5	30.7	26.1	26.2	29.7
	20.1	19.3	17.7	18.9	13.6	10.5	17.3	14.1	14.2	13.8	8.2
AVE	20.3	19.2	16.7	21.5	20.9	18.2	18.9	22.4	20.2	20.0	19.0
1974 CHEVROLET IMPALA	17.6	16.5	21.8	26.2	21.8	22.6	.	22.5	.	21.3	.
	18.4	16.3	18.8	24.7	27.8	22.0	.	22.2	.	19.8	.
	.	.	.	20.6	.	.	.	.	.	.	.
AVE	18.0	16.4	20.3	23.8	24.8	22.3	.	22.3	.	20.5	.
1977 HONDA CIVIC 49 STATE	20.6	20.3	21.6	23.2	24.5	28.4	.	32.5	.	33.6	.
	19.7	22.5	15.5	19.4	22.8	27.9	.	29.8	.	34.7	.
AVE	20.1	21.4	18.6	21.3	23.6	28.2	.	31.1	.	34.1	.
1977 FORD LTD 49 STATE	20.3	21.2	21.7	27.9	27.2	25.1	22.4	28.8	29.1	27.4	29.0
	20.5	22.2	23.4	24.9	24.4	24.6	25.2	25.8	24.2	24.6	26.8
	21.5	.	.	.	.	.	.	.	.	.	.
AVE	20.8	21.7	22.6	26.4	25.8	24.8	23.8	27.3	26.6	26.0	27.9
1977 PLYMOUTH FURY 49S	14.3	18.8	23.9	19.5	24.1	20.9	.	27.8	.	29.1	.
	17.2	17.3	16.0	13.2	18.0	19.8	.	26.1	.	28.5	.
	.	.	.	18.6	25.1	.	.	.	.	.	.
AVE	15.7	18.1	19.9	17.1	22.4	20.3	.	27.0	.	28.8	.
1978 BUICK V6 TURBOCHARGE	12.4	11.6	13.2	11.4	12.3	14.4	15.4	19.8	19.5	22.5	20.9
	12.4	11.5	11.4	11.6	13.2	14.6	16.4	15.6	15.9	16.5	23.4
	13.1	.	.	.	.	.	.	.	.	.	.
AVE	12.6	11.5	12.3	11.5	12.7	14.5	15.9	17.7	17.7	19.5	22.2
1977 PLYMOUTH FURY CALIF	17.3	18.5	19.1	16.6	9.7	7.5	19.7	20.4	19.5	18.3	18.9
	17.2	19.4	19.4	14.1	15.3	19.5	16.1	14.3	24.4	13.1	17.3
	.	.	.	.	.	.	.	.	.	.	20.1
AVE	17.3	19.0	19.2	15.4	12.5	13.5	17.9	14.3	21.9	15.7	18.8
1976 CHEVROLET ST W-CALIF	10.8	15.9	20.0	17.7	13.7	17.3	16.7	12.8	12.2	9.0	22.5
	15.7	15.8	18.9	15.6	17.9	15.7	16.8	14.7	17.4	16.1	18.1
AVE	13.2	15.8	19.5	16.7	15.8	16.5	16.8	13.7	14.8	12.6	20.3
1976 FORD PINTO CAL 3 WAY	15.4	20.2	19.8	10.0	9.6	6.8	10.5	9.6	8.5	5.6	8.7
	16.4	16.7	18.8	9.7	9.5	10.5	8.6	8.9	9.5	13.3	8.3
	15.5	.	.	.	.	.	.	6.9	.	.	10.9
AVE	15.8	18.5	19.3	9.8	9.5	8.7	9.6	8.4	9.0	9.4	9.3
1978 VW RABBIT CAL FU-INJ	17.6	17.5	19.3	21.0	19.2	20.1	.	21.6	.	24.7	.
	18.5	20.2	19.5	18.1	19.0	18.1	.	21.9	.	25.3	.
AVE	18.0	18.9	19.4	19.5	19.1	19.1	.	21.8	.	25.0	.
1979 DODGE ASPEN CALIF.	23.4	26.0	28.5	9.6	9.8	9.4	10.7	10.2	8.6	11.0	13.2
	22.3	19.4	23.7	8.0	7.1	7.1	9.3	11.2	10.8	10.4	13.5
AVE	22.9	22.7	26.1	8.8	8.5	8.4	10.0	10.7	9.7	10.7	13.4
1980 MERCURY PROTOTYPE	.	19.6	18.7	10.9	8.3	8.3	9.2	9.3	9.2	9.0	9.7
	.	17.5	.	.	9.1	7.1	.	.	.	10.1	10.6
AVE	.	18.5	18.7	10.9	8.7	7.7	9.2	9.3	9.2	9.6	10.1
1980 BUICK REGAL PROTOTYP	.	22.9	20.8	9.0	22.4	19.9	16.3	18.7	17.0	15.7	16.7
	.	25.8	.	.	20.6	19.5	.	.	.	17.5	20.9
AVE	.	24.4	20.8	9.0	21.5	19.7	16.3	18.7	17.0	16.6	18.8
DATSUN PROTOTYPE	14.0	11.8	14.3	9.3	7.3	8.8	.	9.1	.	6.6	.
	13.2	13.5	12.2	10.3	8.9	9.8	.	7.1	.	8.5	.
	.	.	13.8	.	.	.	.	.	.	.	.
AVE	13.6	12.6	13.4	9.8	8.1	9.3	.	8.1	.	7.5	.

TABLE 80 GAS CHROMATOGRAPHIC ANALYSIS

STABILIZED FTP - OLEFINS- % BY WT

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	23.1	18.1	14.3	23.1	32.1	22.3	17.4	32.9	28.1	32.8	32.7
	8.9	23.0	32.0	18.6	11.4	8.0	16.4	17.0	15.4	15.3	8.8
AVE	16.0	20.6	23.1	20.9	21.7	15.2	16.9	24.9	21.7	24.0	20.7
1974 CHEVROLET IMPALA	20.9	16.9	22.2	34.5	21.6	23.8	.	22.1	.	14.4	.
	21.9	25.8	21.7	21.8	20.1	22.3	.	23.0	.	25.1	.
	.	.	.	16.9	.	.	.	.	.	.	.
AVE	21.4	21.3	21.9	24.4	20.9	23.1	.	22.5	.	19.8	.
1977 HONDA CIVIC 49 STATE	28.0	24.5	49.6	46.1	50.4	42.8	.	47.8	.	45.6	.
	27.6	27.2	34.6	48.4	45.0	49.1	.	47.6	.	46.3	.
AVE	27.8	25.9	42.1	47.2	47.7	46.0	.	47.7	.	45.9	.
1977 FORD LTD 49 STATE	17.6	16.8	12.1	16.8	14.8	16.8	22.2	19.3	25.4	27.2	28.0
	16.1	16.2	18.2	15.3	18.5	17.8	22.9	16.7	24.6	23.9	26.6
	16.9	.	.	.	.	.	.	.	.	.	.
AVE	16.9	16.5	15.1	16.0	16.6	17.3	22.6	18.0	25.0	25.6	27.3
1977 PLYMOUTH FURY 49S	30.8	23.0	14.8	12.8	19.7	14.6	.	15.5	.	31.4	.
	24.6	27.9	22.1	13.7	22.7	16.3	.	16.0	.	27.4	.
	.	.	.	16.1	13.2	.	.	.	.	.	.
AVE	27.7	25.5	18.5	14.2	18.5	15.4	.	15.7	.	29.4	.
1978 BUICK V6 TURBOCHARGE	3.6	3.5	3.4	4.7	8.1	2.8	5.7	2.8	4.7	5.4	5.9
	4.1	2.4	1.5	3.9	3.2	3.3	2.5	7.5	4.5	5.0	4.5
	3.1	.	.	.	.	.	.	.	.	.	.
AVE	3.6	3.0	2.5	4.3	5.6	3.0	4.1	5.2	4.6	5.2	5.2
1977 PLYMOUTH FURY CALIF	3.2	2.5	3.9	9.6	0.0	1.4	5.5	2.8	10.6	2.2	31.5
	3.1	4.0	3.4	4.7	6.2	2.7	5.7	6.7	5.5	7.9	11.8
	.	.	.	.	.	.	.	.	.	.	10.9
AVE	3.1	3.3	3.7	7.2	3.1	2.0	5.6	6.7	8.0	5.1	18.1
1978 CHEVROLET ST W-CALIF	4.5	2.8	7.0	6.4	5.9	5.1	6.5	4.2	4.9	2.6	13.4
	5.5	7.7	8.7	3.3	5.6	5.4	10.7	4.2	6.5	6.9	13.2
AVE	5.0	5.3	7.9	4.8	5.8	5.3	8.6	4.2	5.7	4.8	13.3
1978 FORD PINTO CAL 3 WAY	3.8	5.2	6.9	6.9	3.3	6.2	5.8	2.5	3.0	3.6	3.3
	17.3	16.5	12.3	3.7	4.7	5.0	2.8	2.6	2.5	7.4	1.7
	15.9	.	.	.	.	.	.	2.7	.	.	4.5
AVE	12.3	10.9	9.6	5.3	4.0	5.6	4.3	2.6	2.7	5.5	3.2
1978 VW RABBIT CAL FU-INJ	21.1	7.9	6.4	15.1	12.6	14.8	.	16.7	.	32.9	.
	32.4	4.0	2.9	8.4	11.4	13.8	.	22.0	.	24.4	.
AVE	26.7	5.9	4.7	11.7	12.0	14.3	.	19.3	.	28.7	.
1979 DODGE ASPEN CALIF.	5.9	5.5	6.5	5.6	4.0	4.5	3.8	4.1	2.7	5.1	3.9
	4.7	7.4	9.1	5.0	5.4	3.8	6.5	3.2	2.9	4.5	4.0
AVE	5.3	6.4	7.8	5.3	4.7	4.1	5.1	3.7	2.8	4.8	3.9
1980 MERCURY PROTOTYPE	.	2.5	2.2	1.2	4.0	0.6	3.0	4.9	9.8	4.1	3.8
	.	1.8	.	.	1.1	1.9	.	.	.	3.4	8.2
AVE	.	2.1	2.2	1.2	2.5	1.3	3.0	4.9	9.8	3.8	6.0
1980 BUICK REGAL PROTOTYP	.	5.7	13.2	0.0	0.0	0.9	0.0	3.4	2.1	2.0	4.2
	.	3.0	.	.	0.0	2.2	.	.	.	2.5	9.0
AVE	.	4.3	13.2	0.0	0.0	1.6	0.0	3.4	2.1	2.3	6.6
DATSUN PROTOTYPE	4.0	4.0	3.0	1.9	2.8	1.6	.	1.0	.	2.0	.
	5.5	3.7	3.2	3.5	2.4	4.6	.	2.8	.	4.2	.
	.	.	1.1	.	.	.	.	.	.	.	.
AVE	4.7	3.9	2.5	2.7	2.6	3.1	.	1.9	.	3.1	.

TABLE 81 GAS CHROMATOGRAPHIC ANALYSIS

HOT TRANSIENT FTP -OLEFINS- % BY WT

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	26.6	17.9	17.3	25.6	31.3	28.2	23.8	28.4	27.5	30.1	29.3
	16.6	8.1	12.0	13.7	11.3	9.1	17.1	17.7	14.7	16.1	12.7
AVE	21.6	13.0	14.7	19.7	21.3	18.7	20.4	23.0	21.1	23.1	21.0
1974 CHEVROLET IMPALA	22.0	20.1	20.8	22.9	21.0	18.7	.	18.5	.	19.7	.
	28.4	19.2	20.6	20.8	18.3	17.3	.	17.3	.	18.9	.
	.	.	.	19.1	.	.	.	.	.	.	.
AVE	25.2	19.6	20.7	21.0	19.7	18.0	.	17.9	.	19.3	.
1977 HONDA CIVIC 49 STATE	39.1	41.3	37.7	36.6	35.4	33.4	.	34.0	.	32.6	.
	38.2	40.1	38.5	35.1	32.7	35.3	.	35.5	.	33.1	.
AVE	38.7	40.7	38.1	35.9	34.0	34.4	.	34.7	.	32.8	.
1977 FORD LTD 49 STATE	22.4	21.7	19.0	21.7	21.4	21.6	24.2	23.1	23.6	26.3	23.0
	20.7	18.2	22.1	21.6	22.5	23.1	21.0	23.0	23.5	23.4	26.7
	20.1	.	.	.	.	.	.	.	.	.	.
AVE	21.0	20.0	20.6	21.6	22.0	22.3	22.6	23.1	23.5	24.9	24.8
1977 PLYMOUTH FURY 495	27.2	23.2	18.7	17.7	22.3	19.3	.	20.4	.	24.9	.
	22.8	27.6	26.1	17.3	21.6	11.4	.	20.9	.	26.9	.
	.	.	.	32.7	18.6	.	.	.	.	.	.
AVE	25.0	25.4	22.4	22.6	20.8	15.4	.	20.7	.	25.9	.
1978 BUICK V6 TURBOCHARGE	16.5	15.6	14.0	12.3	11.6	9.1	10.9	13.7	12.6	15.7	16.3
	16.5	9.2	7.9	12.5	12.0	13.3	12.1	13.0	11.3	12.2	14.3
	10.5	.	.	.	.	.	.	.	.	.	.
AVE	14.5	12.4	11.0	12.4	11.8	11.2	11.5	13.4	11.9	13.9	15.3
1977 PLYMOUTH FURY CALIF	5.8	10.3	12.5	11.2	9.7	10.3	12.4	15.5	16.8	13.8	12.4
	11.2	11.6	13.5	12.9	13.1	14.7	13.7	8.?	16.1	17.5	14.2
	.	.	.	.	.	.	.	.	.	.	16.8
AVE	8.5	10.9	13.0	12.0	11.4	12.5	13.0	8.2	16.5	15.6	14.5
1978 CHEVROLET ST W-CALIF	9.8	9.7	4.8	2.9	10.3	10.0	9.8	8.5	7.9	6.0	10.3
	8.5	10.7	7.5	6.7	8.6	9.6	7.4	6.7	11.4	8.1	12.2
AVE	9.1	10.2	6.1	4.8	9.5	9.8	8.6	7.6	9.6	7.0	11.3
1978 FORD PINTO CAL 3 WAY	7.3	8.1	7.7	5.2	6.7	10.8	7.9	5.7	6.3	6.3	7.7
	9.2	18.2	15.1	4.1	5.1	8.1	5.9	6.0	4.6	11.0	7.7
	5.4	.	.	.	.	.	.	4.4	.	.	7.6
AVE	7.3	13.1	11.4	4.7	5.9	9.4	6.9	5.4	5.5	8.6	7.6
1978 VW RABBIT CAL FU-INJ	17.3	16.9	16.8	16.7	18.3	11.3	.	20.6	.	25.5	.
	23.4	15.2	15.9	16.0	13.9	18.5	.	22.9	.	25.3	.
AVE	20.3	16.1	16.4	16.3	16.1	14.9	.	21.8	.	25.4	.
1979 DODGE ASPEN CALIF.	7.3	2.9	9.3	8.1	4.7	6.4	5.1	5.3	8.3	8.0	7.2
	7.3	11.6	11.8	9.6	8.1	6.2	7.2	6.1	7.3	7.5	7.0
AVE	7.3	7.2	10.5	8.9	6.4	6.3	6.2	5.7	7.8	7.7	7.1
1980 MERCURY PROTOTYPE	.	10.0	11.3	7.9	11.3	8.3	10.5	8.9	9.7	8.7	8.7
	.	7.8	.	.	8.3	7.7	.	.	.	12.9	10.6
AVE	.	8.9	11.3	7.9	9.8	8.0	10.5	8.9	9.7	10.8	9.6
1980 BUICK REGAL PROTOTYP	.	15.1	14.4	9.8	11.7	6.5	7.6	7.2	6.0	12.8	13.9
	.	12.5	.	.	10.9	7.2	.	.	.	8.2	16.4
AVE	.	13.8	14.4	9.8	11.3	6.8	7.6	7.2	6.0	10.5	15.1
DATSUN PROTOTYPE	6.0	3.5	4.9	3.2	2.2	2.9	.	2.2	.	4.7	.
	4.9	4.8	4.5	3.8	4.0	3.7	.	2.8	.	3.6	.
	.	.	4.8	.	.	.	.	.	.	.	.
AVE	5.5	4.1	4.8	3.5	3.1	3.3	.	2.5	.	4.2	.

Aromatics--Table 82 lists the percent aromatics in the exhaust hydrocarbons for the cold transient phase of the FTP.

TABLE 82 GAS CHROMATOGRAPHIC ANALYSIS

COLD TRANSIENT FTP - AROMATICS- % BY WT

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	11.0	14.7	21.7	16.1	15.1	7.8	23.8	15.3	18.8	17.1	17.0
	10.9	15.7	19.7	21.2	25.5	22.7	25.9	29.5	28.4	21.7	23.1
AVE	10.9	15.2	20.7	19.6	20.3	15.2	24.9	22.4	23.6	19.4	20.0
1974 CHEVROLET IMPALA	13.4	11.2	14.8	15.1	17.2	15.9	.	17.1	.	17.7	.
	9.7	12.5	11.6	16.9	11.5	17.9	.	18.0	.	17.7	.
	.	.	.	18.8	.	.	.	.	.	.	.
AVE	11.5	11.9	13.2	16.9	14.3	16.9	.	17.6	.	17.7	.
1977 HONDA CIVIC 49 STATE	15.8	15.6	17.1	22.6	24.2	23.6	.	20.4	.	22.0	.
	15.1	16.1	16.6	24.9	26.2	23.2	.	24.3	.	20.5	.
AVE	15.5	15.8	16.9	23.6	25.2	23.4	.	22.4	.	21.2	.
1977 FORD LTD 49 STATE	14.4	13.5	15.3	16.4	18.7	18.7	21.0	18.5	19.0	18.8	21.0
	13.1	13.5	11.3	19.3	19.4	19.7	18.5	21.0	17.4	19.1	19.8
	13.9	.	.	.	.	.	.	.	.	.	.
AVE	13.8	13.5	13.3	17.8	19.0	19.2	19.8	19.7	18.2	18.9	20.4
1977 PLYMOUTH FURY 49S	17.0	12.9	12.1	27.0	18.0	19.2	.	19.5	.	18.8	.
	12.9	10.7	12.6	19.0	23.0	23.9	.	20.2	.	20.6	.
	.	.	.	22.9	21.3	.	.	.	.	.	.
AVE	14.9	11.8	12.3	23.0	20.8	21.6	.	19.9	.	19.7	.
1978 BUICK V6 TURBOCHARGE	17.7	20.0	18.9	24.0	23.9	23.1	24.4	15.2	16.2	15.8	20.9
	17.1	16.9	17.3	22.1	23.1	22.9	21.5	22.3	21.7	19.3	17.2
	17.0	.	.	.	.	.	.	.	.	.	.
AVE	17.3	18.5	18.1	21.1	23.5	23.0	23.0	18.8	19.0	17.6	19.1
1977 PLYMOUTH FURY CALIF	15.4	15.3	16.6	21.2	21.6	21.0	18.4	15.9	18.4	15.8	18.2
	12.7	13.5	14.3	16.2	19.1	16.4	18.5	15.2	16.8	20.7	19.8
	.	.	.	.	.	.	.	.	.	.	18.2
AVE	14.0	14.4	15.4	18.7	20.3	18.7	18.4	15.2	17.6	18.3	18.7
1978 CHEVROLET ST W-CALIF	11.9	14.7	11.3	20.2	28.1	19.2	21.4	22.6	25.5	23.3	22.0
	13.4	15.0	15.4	21.6	21.7	20.1	21.3	21.3	22.1	21.4	23.0
AVE	12.7	14.9	13.3	20.9	24.9	19.6	21.3	22.0	23.8	22.3	22.5
1978 FORD PINTO CAL 3 WAY	16.5	14.5	13.5	21.2	21.5	22.4	21.0	18.0	20.6	25.8	18.7
	15.1	13.4	13.1	22.0	19.5	21.5	20.6	19.7	18.9	18.1	21.3
	13.0	.	.	.	.	.	.	13.5	.	.	20.5
AVE	14.9	13.9	13.3	21.6	20.5	21.9	20.8	17.1	19.7	22.0	20.2
1978 VW RABBIT CAL FU-INJ	21.5	21.7	21.1	13.7	21.4	22.5	.	21.3	.	23.6	.
	20.6	18.6	18.2	25.0	24.8	24.1	.	26.1	.	24.0	.
AVE	21.0	20.2	19.7	19.3	23.1	23.3	.	23.7	.	23.8	.
1979 DODGE ASPEN CALIF.	16.1	15.0	15.8	24.0	20.1	18.6	22.0	24.6	19.0	21.4	21.9
	16.2	17.2	15.1	24.4	25.0	26.9	25.9	22.4	19.9	22.7	20.7
AVE	16.1	16.1	15.5	24.2	22.6	22.7	23.9	23.5	19.5	22.0	21.3
1980 MERCURY PROTOTYPE	.	16.1	15.6	20.0	11.7	12.9	14.4	13.7	17.0	19.3	19.6
	.	17.8	.	.	12.1	13.7	.	.	.	20.8	18.4
AVE	.	16.9	15.8	20.0	11.9	13.3	14.4	13.7	17.0	20.1	19.0
1980 BUICK REGAL PROTOTYP	.	20.2	18.8	13.5	26.4	24.7	25.7	22.5	27.2	27.0	26.5
	.	19.4	.	.	25.3	23.6	.	.	.	24.8	23.8
AVE	.	19.8	18.8	13.5	25.8	24.2	25.7	22.5	27.2	25.9	25.2
DATSUN PROTOTYPE	17.0	17.1	19.1	24.2	39.4	26.3	.	27.8	.	25.9	.
	15.7	16.6	19.1	24.6	25.7	25.7	.	32.9	.	25.6	.
	.	.	17.7	.	.	.	.	.	.	.	.
AVE	16.3	16.9	18.6	24.4	32.6	26.0	.	30.4	.	25.8	.

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Table 83, which lists the aromatics for the stabilized phase of the FTP, shows that the aromatics may be selectively destroyed by catalysts where very low aromatic concentrations were obtained. However, this was not true for all catalyst systems under all conditions.

TABLE 83 GAS CHROMATOGRAPHIC ANALYSIS

STABILIZED FTP - AROMATICS- % BY WT

TEMPERATURE F		0	20	40	60	70	80	80AC	90	90AC	110	110AC
(C)		(-18)	(-7)	(4)	(16)	(21)	(27)	(27)	(32)	(32)	(43)	(43)
1972 CHEVROLET IMPALA		29.7	31.7	36.2	21.3	20.1	17.9	28.1	19.0	21.1	17.5	18.9
		25.9	28.3	19.5	33.0	33.1	25.9	27.3	35.0	32.8	25.1	22.0
	AVE	27.8	30.0	27.8	27.1	26.6	21.9	27.7	27.0	26.9	21.3	20.5
1974 CHEVROLET IMPALA		25.2	19.9	16.3	16.9	17.2	15.2	.	18.4	.	24.3	.
		27.9	24.4	16.8	18.1	16.5	19.6	.	19.7	.	19.4	.
		.	.	.	20.0	.	.	.	.	.	.	.
	AVE	26.5	22.2	16.6	18.3	16.9	17.4	.	19.0	.	21.9	.
1977 HONDA CIVIC 49 STATE		14.3	14.4	10.7	13.5	17.5	18.3	.	16.2	.	17.3	.
		15.0	13.8	15.3	18.1	16.8	17.5	.	17.5	.	16.4	.
	AVE	14.7	14.1	13.0	15.8	17.1	17.9	.	16.9	.	16.8	.
1977 FORD LTD 49 STATE		21.5	15.8	17.2	19.4	24.4	16.3	23.0	23.6	22.5	20.3	19.9
		23.1	20.9	22.6	27.1	25.9	23.5	23.8	26.9	23.2	23.7	21.2
		21.1	.	.	.	.	.	.	.	.	.	.
	AVE	21.9	18.4	19.9	23.2	25.2	19.9	23.4	25.2	22.9	22.0	20.5
1977 PLYMOUTH FURY 49S		14.4	11.8	11.1	17.6	16.6	11.7	.	11.7	.	20.0	.
		14.6	14.2	14.5	17.0	23.1	14.9	.	14.6	.	20.2	.
		.	.	.	20.6	13.3	.	.	.	.	.	.
	AVE	14.5	13.0	12.8	18.4	17.7	13.3	.	13.2	.	20.1	.
1978 BUICK V6 TURBOCHARGE		9.0	11.3	10.2	7.8	11.6	4.2	4.4	2.7	3.6	4.5	5.5
		7.6	5.0	14.6	3.7	14.6	4.0	23.6	4.8	5.4	8.0	6.6
		16.8	.	.	.	.	.	.	.	.	.	.
	AVE	11.1	8.1	12.4	5.7	13.1	4.1	14.0	3.7	4.5	6.3	6.0
1977 PLYMOUTH FURY CALIF		21.7	12.6	14.3	13.5	25.0	12.7	8.6	3.1	13.1	6.9	8.0
		15.5	4.6	11.1	6.0	12.1	6.7	5.6	12.0	8.0	14.2	14.1
		.	.	.	.	.	.	.	.	.	.	13.9
	AVE	18.6	8.6	12.7	9.8	18.5	9.7	7.1	12.0	10.5	10.5	12.0
1978 CHEVROLET ST W-CALIF		8.4	3.2	3.0	8.7	8.4	4.8	2.0	4.0	3.8	5.4	8.5
		6.4	6.0	3.3	5.1	5.2	4.2	2.7	5.5	4.6	1.4	4.9
	AVE	8.4	4.6	3.2	6.9	6.8	4.5	2.4	4.7	4.2	3.4	6.7
1978 FORD PINTO CAL 3 WAY		9.8	5.3	5.2	4.7	4.0	6.0	6.8	7.3	4.4	5.5	4.8
		14.2	15.2	11.1	4.4	4.4	6.4	3.8	4.8	1.8	9.3	3.7
		14.9	.	.	.	.	.	.	2.1	.	.	5.5
	AVE	12.9	10.2	8.2	4.5	4.2	6.2	5.3	4.7	3.1	7.4	4.7
1978 VW RABBIT CAL FU-INJ		17.4	10.1	15.4	8.2	21.2	18.1	.	21.3	.	20.3	.
		17.0	8.5	9.6	14.4	21.5	22.0	.	24.4	.	23.1	.
	AVE	17.2	9.3	12.5	11.3	21.3	20.0	.	22.8	.	21.7	.
1979 DODGE ASPEN CALIF.		5.6	7.5	4.4	4.3	18.8	5.7	18.1	6.0	16.0	6.7	12.1
		8.2	4.6	5.0	6.9	5.5	6.1	5.5	5.2	5.9	10.5	7.9
	AVE	6.9	6.1	4.7	5.6	12.2	5.9	11.8	5.6	10.9	8.6	10.0
1980 MERCURY PROTOTYPE		.	12.5	4.8	3.5	9.5	3.5	14.0	5.0	4.4	3.9	4.8
		.	8.1	.	.	5.6	6.4	.	.	.	6.9	3.1
	AVE	.	10.3	4.8	3.5	7.6	4.9	14.0	5.0	4.4	5.4	3.9
1980 BUICK REGAL PROTOTYP		.	4.0	13.4	2.3	5.2	3.5	1.1	1.6	2.0	8.6	13.8
		.	6.2	.	.	3.1	7.4	.	.	.	3.5	12.4
	AVE	.	5.1	13.4	2.3	4.1	5.4	1.1	1.6	2.0	6.1	13.1
DATSUN PROTOTYPE		2.5	5.1	2.3	3.6	9.0	5.3	.	6.8	.	7.6	.
		2.9	3.5	1.8	8.7	3.8	6.8	.	5.2	.	9.2	.
		.	.	32.2	.	.	.	.	.	.	.	.
	AVE	2.7	4.3	12.1	6.2	6.4	6.1	.	6.0	.	8.4	.

The hot transient phase data given in Table 84 show the effect of starting and warm up. The fraction of aromatics present for the noncatalyst cars was reasonably comparable to data obtained during the stabilized phase. The catalyst cars had aromatics fractions intermediate between those levels found in the cold transient and the stabilized phases.

TABLE 84 GAS CHROMATOGRAPHIC ANALYSIS

HOT TRANSIENT FTP -AROMATICS- % BY WT

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	15.8	27.1	24.2	18.6	16.7	16.8	17.2	14.8	18.6	15.8	16.2
	18.8	31.9	34.8	30.6	28.1	26.3	27.9	28.6	31.5	20.5	18.1
AVE	17.3	29.5	29.5	24.6	22.4	21.5	22.6	21.7	25.0	18.2	17.2
1974 CHEVROLET IMPALA	16.8	15.5	13.5	17.0	14.2	13.4	.	14.6	.	14.9	.
	12.9	15.2	13.6	15.2	21.5	16.5	.	15.7	.	15.1	.
	.	.	.	20.3	.	.	.	.	.	.	.
AVE	14.9	15.3	13.6	17.5	17.8	15.0	.	15.1	.	15.0	.
1977 HONDA CIVIC 49 STATE	14.4	14.3	14.0	18.8	18.7	20.4	.	19.1	.	19.6	.
	15.1	14.3	13.8	19.2	20.9	20.3	.	19.9	.	19.9	.
AVE	14.8	14.3	13.9	19.0	19.8	20.4	.	19.5	.	19.8	.
1977 FORD LTD 49 STATE	14.6	14.7	13.0	15.0	14.9	14.9	16.8	15.8	22.0	16.1	14.9
	16.2	16.0	13.8	19.6	18.6	15.9	17.0	16.3	17.6	18.0	16.6
	15.7	.	.	.	.	.	.	.	.	.	.
AVE	15.5	15.3	13.4	17.3	16.8	15.4	16.9	16.1	19.8	17.0	15.7
1977 PLYMOUTH FURY 49S	14.1	14.5	22.4	19.1	17.3	16.9	.	15.1	.	18.7	.
	14.3	13.8	14.1	18.8	20.8	21.4	.	18.3	.	23.0	.
	.	.	.	15.0	23.2	.	.	.	.	.	.
AVE	14.2	14.2	18.2	17.6	20.4	19.2	.	16.7	.	20.8	.
1978 BUICK V6 TURBOCHARGE	12.2	11.7	8.3	11.2	13.1	10.3	11.8	8.5	10.0	9.2	11.8
	16.5	16.0	21.5	12.3	11.8	17.1	12.3	12.9	13.4	12.7	12.2
	17.6	.	.	.	.	.	.	.	.	.	.
AVE	15.4	13.9	14.9	11.7	12.4	13.7	12.1	10.7	11.7	11.0	12.0
1977 PLYMOUTH FURY CALIF	8.4	11.9	13.1	26.4	15.5	14.1	15.4	15.7	11.3	11.9	14.1
	9.7	6.6	8.5	18.1	15.2	14.6	13.8	48.0	17.6	17.1	15.4
	.	.	.	.	.	.	.	.	.	.	14.6
AVE	9.0	9.2	10.8	22.3	15.4	14.4	14.6	48.0	14.5	14.5	14.7
1978 CHEVROLET ST W-CALIF	10.3	4.9	4.1	6.8	8.0	9.7	8.8	6.7	9.1	9.2	12.6
	6.3	6.6	5.0	6.3	7.6	8.5	10.5	12.3	7.1	9.7	13.0
AVE	8.3	5.6	4.6	6.5	7.8	9.1	9.6	9.5	8.1	9.5	12.8
1976 FORD PINTO CAL 3 WAY	6.7	4.8	5.1	7.7	9.0	13.3	9.9	6.6	7.9	7.6	10.0
	8.4	11.4	8.6	6.2	7.3	7.3	6.9	5.3	6.0	10.0	8.5
	5.7	.	.	.	.	.	.	3.4	.	.	7.3
AVE	6.9	8.1	6.9	7.0	8.2	10.3	8.4	5.1	6.9	8.8	8.6
1978 VW RABBIT CAL FU-INJ	16.3	14.5	17.3	9.9	20.5	20.0	.	20.9	.	21.7	.
	16.4	12.5	14.1	22.0	25.1	23.9	.	23.5	.	23.0	.
AVE	16.3	13.5	15.7	15.9	22.8	22.0	.	22.2	.	22.4	.
1979 DODGE ASPEN CALIF.	8.8	1.4	8.3	11.2	11.5	13.3	11.4	12.9	14.4	14.6	16.5
	6.6	8.5	9.4	14.8	13.7	14.8	14.0	14.1	15.2	16.6	15.9
AVE	7.7	4.9	8.8	13.0	12.6	14.1	12.7	13.5	14.8	15.6	16.2
1980 MERCURY PROTOTYPE	.	13.1	9.9	18.8	14.9	22.2	15.9	14.1	12.6	18.2	13.1
	.	11.1	.	.	13.5	17.7	.	.	.	14.2	19.9
AVE	.	12.1	9.9	18.8	14.2	19.9	15.9	14.1	12.6	16.2	16.5
1980 BUICK REGAL PROTOTYP	.	14.8	10.4	17.1	17.3	12.1	14.8	10.4	16.1	18.0	20.2
	.	12.5	.	.	14.2	13.3	.	.	.	16.1	20.4
AVE	.	13.7	10.4	17.1	15.7	12.7	14.8	10.4	16.1	17.1	20.3
DATSUN PROTOTYPE	11.6	7.5	5.7	11.0	19.9	12.3	.	14.5	.	13.0	.
	14.6	7.9	9.0	10.3	9.0	12.9	.	10.7	.	15.1	.
	.	.	6.6	.	.	.	.	.	.	.	.
AVE	13.1	7.7	7.1	10.6	14.5	12.6	.	12.6	.	14.0	.

Benzene--Recently benzene has been of concern since it has been shown to be a carcinogen. The fuels used in this study had benzene concentrations of 0.3% and 0.2% for the summer and winter fuels, respectively. Tables 85, 86 and 87 show that the exhaust gases from the various phases of the FTP had a much higher relative concentration of benzene than the original fuel.

TABLE 85 GAS CHROMATOGRAPHIC ANALYSIS

COLD TRANSIENT FTP - BENZENE, % TOTAL HC

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	2.3	2.9	2.7	3.0	3.4	1.4	2.4	4.0	3.7	4.0	4.2
	2.6	2.6	3.2	3.4	2.9	2.3	3.1	3.0	2.9	2.9	1.9
AVE	2.5	2.7	2.9	3.2	3.1	1.9	2.8	3.5	3.3	3.4	3.1
1974 CHEVROLET IMPALA	2.8	2.4	3.0	3.7	3.3	3.4	.	3.0	.	2.9	.
	2.7	2.5	3.0	3.6	4.0	3.0	.	3.3	.	2.9	.
	.	.	.	3.1	.	.	.	.	.	.	.
AVE	2.7	2.5	3.0	3.5	3.7	3.2	.	3.2	.	2.9	.
1977 HONDA CIVIC 49 STATE	2.7	2.6	2.4	3.2	3.6	3.9	.	4.6	.	4.0	.
	2.4	2.4	1.5	3.0	3.5	4.0	.	4.0	.	4.4	.
AVE	2.6	2.5	2.0	3.1	3.5	3.9	.	4.3	.	4.2	.
1977 FORD LTD 49 STATE	3.5	3.3	3.8	5.5	5.7	5.1	6.3	6.6	5.6	4.4	5.7
	3.2	3.5	3.7	5.3	5.6	4.9	5.4	5.9	4.8	0.5	5.1
	3.5	.	.	.	.	.	.	.	.	.	.
AVE	3.4	3.4	3.8	5.4	5.7	5.0	5.8	6.3	5.2	2.4	5.4
1977 PLYMOUTH FURY 495	1.7	2.0	2.4	3.4	3.4	3.1	.	3.5	.	3.4	.
	1.9	1.9	2.1	2.7	3.0	3.8	.	3.4	.	3.7	.
	.	.	.	3.5	3.9	.	.	.	.	.	.
AVE	1.8	1.9	2.3	3.2	3.5	3.5	.	3.5	.	3.5	.
1978 BUICK V6 TURBOCHARGE	1.8	1.7	2.0	2.6	2.7	2.8	3.4	2.4	2.7	2.4	3.6
	1.9	1.7	1.7	2.7	2.7	2.8	3.7	1.2	3.1	2.3	3.1
	1.9	.	.	.	.	.	.	.	.	.	.
AVE	1.9	1.7	1.9	2.7	2.7	2.8	3.5	1.8	2.9	2.4	3.4
1977 PLYMOUTH FURY CALIF	2.9	3.3	3.8	3.8	3.8	4.3	4.5	4.2	4.6	5.0	3.9
	2.4	2.4	3.0	3.3	3.5	4.3	3.7	3.2	4.3	3.3	4.9
	.	.	.	.	.	.	.	.	.	.	3.8
AVE	2.7	3.0	3.4	3.6	3.6	4.3	4.1	3.7	4.5	4.2	4.2
1978 CHEVROLET ST 4-CALIF	1.1	2.1	2.3	3.0	3.6	3.3	3.5	2.8	2.7	2.4	4.6
	2.0	2.0	2.4	3.8	3.3	3.0	3.2	2.9	3.7	3.0	3.2
AVE	1.5	2.0	2.4	3.4	3.4	3.1	3.3	2.8	3.2	2.7	3.9
1978 FORD PINTO CAL 3 WAY	2.5	2.5	2.4	3.7	2.8	2.3	2.9	2.6	2.6	1.6	3.1
	2.5	2.4	2.4	3.0	2.8	3.9	2.4	2.0	3.2	3.1	2.5
	2.3	.	.	.	.	.	.	2.4	.	.	3.6
AVE	2.4	2.4	2.4	3.4	2.8	3.1	2.7	2.3	2.9	2.4	3.0
1978 VW RABBIT CAL FU-INJ	3.2	3.5	3.5	2.7	3.9	4.2	.	4.2	.	4.0	.
	3.3	3.1	2.9	4.1	4.4	4.0	.	4.9	.	3.8	.
AVE	3.2	3.3	3.2	3.4	4.1	4.1	.	4.5	.	3.9	.
1979 DODGE ASPEN CALIF.	3.0	2.9	3.1	3.6	3.6	3.2	3.4	3.4	3.4	3.6	5.3
	3.0	3.5	3.3	2.7	2.4	2.8	3.3	4.0	4.6	3.3	5.3
AVE	3.0	3.2	3.2	3.1	3.0	3.0	3.4	3.7	4.0	3.5	5.3
1980 MERCURY PROTOTYPE	.	2.7	2.7	3.9	3.1	3.2	2.9	3.0	2.8	2.5	2.8
	.	3.0	.	.	3.5	3.2	.	.	.	2.3	3.2
AVE	.	2.8	2.7	3.9	3.3	3.2	2.9	3.0	2.8	2.4	3.0
1980 BUICK REGAL PROTOTYPE	.	3.1	3.0	2.9	4.2	3.8	3.0	3.5	3.6	3.1	3.7
	.	3.2	.	.	4.3	3.7	.	.	.	4.1	4.1
AVE	.	3.1	3.0	2.9	4.2	3.8	3.0	3.5	3.6	3.6	3.9
DATSUN PROTOTYPE	3.1	3.2	2.5	3.0	3.1	3.2	.	3.2	.	2.3	.
	2.9	2.6	3.1	3.7	3.2	4.0	.	2.7	.	3.0	.
	.	.	3.7	.	.	.	.	.	.	.	.
AVE	3.0	2.9	3.2	3.3	3.2	3.6	.	3.0	.	2.7	.

TABLE 86 GAS CHROMATOGRAPHIC ANALYSIS

				STABILIZED FTP - BENZENE, % TOTAL HC							
TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	3.7	2.7	2.4	3.5	4.4	3.2	2.3	5.1	4.2	5.4	5.0
	1.9	3.1	4.4	3.8	2.3	2.1	3.1	3.4	3.3	3.6	2.0
AVE	2.8	2.9	3.4	3.6	3.4	2.6	2.7	4.2	3.7	4.5	3.5
1974 CHEVROLET IMPALA	2.2	1.7	2.2	2.7	3.1	3.1	.	2.9	.	1.8	.
	2.3	2.1	2.1	2.7	2.5	3.0	.	3.2	.	3.3	.
	.	.	.	2.3	.	.	.	.	.	.	.
AVE	2.2	1.9	2.1	2.6	2.8	3.1	.	3.1	.	2.6	.
1977 HONDA CIVIC 49 STATE	2.7	2.5	5.2	5.9	6.1	6.2	.	5.8	.	5.3	.
	2.6	2.6	3.6	5.9	5.8	6.1	.	6.3	.	5.2	.
AVE	2.7	2.5	4.4	5.9	6.0	6.2	.	6.0	.	5.3	.
1977 FORD LTD 49 STATE	7.1	8.4	6.8	8.7	10.5	8.1	9.7	10.3	9.3	7.3	5.8
	6.2	6.2	6.5	9.1	10.4	9.9	10.9	9.1	10.3	8.5	6.2
	6.5	.	.	.	.	.	.	.	.	.	.
AVE	6.6	7.3	6.6	8.9	10.4	9.0	10.3	9.7	9.8	7.9	6.0
1977 PLYMOUTH FURY 49S	2.6	2.9	2.4	3.6	4.3	3.1	.	3.0	.	5.2	.
	3.2	2.9	2.5	3.1	5.2	3.9	.	3.6	.	5.5	.
	.	.	.	4.1	3.1	.	.	.	.	.	.
AVE	2.9	2.9	2.5	3.6	4.1	3.5	.	3.3	.	5.1	.
1978 BUICK V6 TURBOCHARGE	1.0	0.8	0.9	1.5	2.3	1.7	1.4	1.4	2.5	3.3	4.5
	0.7	0.6	0.6	1.3	1.6	1.9	2.1	2.0	2.5	5.4	5.3
	0.8	.	.	.	.	.	.	.	.	.	.
AVE	0.9	0.7	0.7	1.4	2.0	1.8	1.7	1.7	2.5	4.3	4.9
1977 PLYMOUTH FURY CALIF	0.8	0.8	0.6	1.2	1.3	1.3	2.7	1.1	4.5	0.5	2.7
	0.9	0.0	0.8	2.0	2.4	0.9	1.8	3.3	2.2	2.9	5.9
	.	.	.	.	.	.	.	.	.	.	5.7
AVE	0.8	0.4	0.7	1.6	1.9	1.1	2.2	3.3	3.3	1.7	4.8
1978 CHEVROLET ST W-CALIF	1.9	1.1	1.1	0.7	1.0	0.8	1.1	0.8	1.6	1.6	6.6
	1.5	1.0	2.3	3.2	1.2	0.9	0.7	1.7	2.4	0.8	3.4
AVE	1.7	1.1	1.7	2.0	1.1	0.9	0.9	1.2	2.0	1.2	5.0
1978 FORD PINTO CAL 3 WAY	1.3	1.2	1.0	1.5	1.3	2.4	2.1	1.2	1.7	1.8	2.8
	3.9	4.9	5.3	1.6	1.7	1.8	1.2	1.3	1.2	2.7	2.2
	4.0	.	.	.	.	.	.	1.1	.	.	2.6
AVE	3.1	3.0	3.2	1.6	1.5	2.1	1.6	1.2	1.5	2.3	2.5
1978 VW RABBIT CAL FU-INJ	5.3	3.9	4.2	3.9	5.6	6.3	.	5.9	.	4.5	.
	4.0	3.0	2.9	4.8	6.0	6.3	.	6.3	.	5.2	.
AVE	4.6	3.4	3.6	4.4	5.8	6.3	.	6.1	.	4.8	.
1979 DODGE ASPEN CALIF.	1.1	1.4	1.8	2.5	2.5	2.0	1.7	2.3	1.8	2.7	3.1
	1.1	1.9	2.1	2.7	2.2	2.1	2.3	1.8	2.5	2.6	3.9
AVE	1.1	1.7	2.0	2.6	2.4	2.1	2.0	2.0	2.1	2.7	3.5
1980 MERCURY PROTOTYPE	.	2.1	1.8	1.2	2.2	1.2	2.1	1.6	2.3	2.1	2.1
	.	1.5	.	.	1.6	2.4	.	.	.	1.7	1.6
AVE	.	1.8	1.8	1.2	1.9	1.8	2.1	1.6	2.3	1.9	1.9
1980 BUICK REGAL PROTOTYP	.	0.7	1.1	1.2	1.1	1.8	1.1	0.8	1.0	4.0	8.3
	.	1.5	.	.	1.1	4.4	.	.	.	3.7	7.9
AVE	.	1.1	1.1	1.2	1.1	3.1	1.1	0.8	1.0	3.8	8.1
DATSUN PROTOTYPE	0.7	1.3	1.2	1.9	1.1	2.4	.	2.0	.	4.7	.
	0.6	0.7	0.6	2.9	1.6	2.7	.	2.7	.	4.2	.
	.	.	2.3	.	.	.	.	.	.	.	.
AVE	0.6	1.0	1.4	2.4	1.4	2.6	.	2.4	.	4.4	.

TABLE 87 GAS CHROMATOGRAPHIC ANALYSIS

HOT TRANSIENT FTP - BENZENE, % TOTAL HC

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	3.2	2.5	2.1	3.3	3.6	3.2	2.6	3.5	3.8	4.4	4.3
	2.4	1.4	2.0	2.5	2.2	2.1	3.3	3.4	3.0	3.2	2.6
AVE	2.8	1.9	2.1	2.9	2.9	2.7	2.9	3.5	3.4	3.8	3.4
1974 CHEVROLET IMPALA	2.3	2.0	1.9	2.9	2.7	2.5	.	2.4	.	2.8	.
	2.1	2.1	2.0	2.7	3.2	2.3	.	2.3	.	2.6	.
	.	.	.	2.6	.	.	.	.	.	.	.
AVE	2.2	2.1	1.9	2.7	2.9	2.4	.	2.4	.	2.7	.
1977 HONDA CIVIC 49 STATE	4.1	4.2	3.4	4.7	4.9	4.2	.	4.1	.	3.9	.
	4.0	3.7	3.5	4.5	4.4	4.1	.	4.5	.	4.0	.
AVE	4.1	4.0	3.5	4.6	4.7	4.1	.	4.3	.	4.0	.
1977 FORD LTD 49 STATE	7.2	7.3	5.7	6.2	5.7	4.9	6.0	5.4	4.7	4.5	3.3
	5.6	5.4	6.5	6.5	7.1	6.2	5.1	5.4	5.5	4.8	4.2
	5.5	.	.	.	.	.	.	.	.	.	.
AVE	6.1	6.3	6.1	6.3	6.4	5.6	5.6	5.4	5.1	4.7	3.8
1977 PLYMOUTH FURY 49S	2.7	2.5	2.3	3.0	3.2	2.8	.	2.8	.	3.7	.
	2.6	2.7	2.7	2.9	3.8	2.8	.	3.2	.	3.7	.
	.	.	.	2.6	3.0	.	.	.	.	.	.
AVE	2.7	2.6	2.5	2.9	3.3	2.8	.	3.0	.	3.7	.
1978 BUICK V6 TURBOCHARGE	1.9	1.8	1.6	3.1	3.1	3.0	3.8	3.1	4.3	4.4	4.8
	1.9	1.6	2.1	3.2	3.5	3.3	3.7	3.7	4.7	5.8	6.2
	1.6	.	.	.	.	.	.	.	.	.	.
AVE	1.8	1.7	1.8	3.2	3.3	3.2	3.7	3.4	4.5	5.1	5.5
1977 PLYMOUTH FURY CALIF	0.8	1.7	2.1	3.5	2.6	2.8	2.8	4.1	3.3	3.0	3.7
	1.4	1.4	1.2	3.5	3.5	3.0	2.9	2.0	4.7	4.8	4.2
	.	.	.	.	.	.	.	.	.	.	4.9
AVE	1.1	1.6	1.7	3.5	3.1	2.9	2.9	2.0	4.0	3.9	4.2
1978 CHEVROLET ST W-CALIF	1.7	0.9	1.1	1.4	1.5	1.3	2.6	1.4	4.4	3.3	6.9
	1.2	1.2	1.1	1.6	1.4	1.4	1.6	1.6	2.7	4.4	7.4
AVE	1.4	1.0	1.1	1.5	1.4	1.4	2.1	1.5	3.6	3.9	7.1
1978 FORD PINTO CAL 3 WAY	1.6	1.0	1.3	2.1	2.2	3.7	2.9	3.2	2.7	2.2	3.7
	1.9	3.8	3.2	1.2	1.4	2.9	2.2	1.5	1.7	3.3	2.7
	1.1	.	.	.	.	.	.	1.6	.	.	3.0
AVE	1.5	2.4	2.3	1.7	1.8	3.3	2.6	2.1	2.2	2.7	3.1
1978 VW RABBIT CAL FU-INJ	4.2	4.0	3.9	3.2	4.9	5.1	.	4.9	.	4.0	.
	3.9	3.8	3.7	4.4	5.4	5.0	.	5.3	.	3.7	.
AVE	4.1	3.9	3.8	3.8	5.2	5.1	.	5.1	.	3.8	.
1979 DODGE ASPEN CALIF.	2.0	1.4	2.2	2.9	2.5	2.5	3.1	2.8	4.4	4.8	6.2
	1.7	1.8	2.1	3.3	3.7	3.6	3.4	3.9	4.4	5.1	5.7
AVE	1.9	1.6	2.1	3.1	3.1	3.1	3.2	3.4	4.4	4.9	6.0
1980 MERCURY PROTOTYPE	.	1.6	1.8	2.4	2.4	2.0	3.2	2.6	1.8	2.1	2.2
	.	1.3	.	.	3.6	2.5	.	.	.	3.3	3.1
AVE	.	1.5	1.8	2.4	3.0	2.3	3.2	2.6	1.8	2.7	2.6
1980 BUICK REGAL PROTOTYP	.	3.1	2.5	4.8	5.0	3.5	5.9	3.2	4.8	5.5	6.8
	.	2.1	.	.	5.0	4.7	.	.	.	5.7	6.1
AVE	.	2.6	2.5	4.8	5.0	4.1	5.9	3.2	4.8	5.6	6.5
DATSUN PROTOTYPE	2.3	2.0	1.7	2.5	2.2	2.8	.	3.8	.	5.2	.
	2.1	1.5	1.1	2.6	2.4	3.6	.	3.5	.	5.6	.
	.	.	1.4	.	.	.	.	.	.	.	.
AVE	2.2	1.7	1.4	2.6	2.3	3.2	.	3.7	.	5.4	.

Because of the interest in benzene, its mass emissions (mg/km) are given in Tables 88-90. The noncatalyst cars in the three phases of the FTP produced average benzene levels from 17 to 494 mg/km. In the cold transient phase of the FTP (Table 88) the maximum benzene emissions occurred at 0°F (-18°C) or 20°F (-7°C). In the stabilized phase, most of the cars had a maximum at 110°F (43°C), sometimes with their air conditioners on. In the hot transient phase (Table 90) high levels of benzene emissions also occurred mainly at high temperatures. The use of catalysts, however, generally reduced benzene levels.

TABLE 88 GAS CHROMATOGRAPHIC ANALYSIS

COLD TRANSIENT FTP - BENZENE, MG/KM

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	283.1	196.0	112.5	80.9	77.8	29.6	56.3	74.4	85.5	89.6	83.4
	302.4	175.4	157.7	113.3	77.6	59.4	88.8	62.2	63.3	67.8	41.9
AVE	292.8	185.7	135.1	97.1	77.7	44.5	72.5	68.3	74.4	78.7	62.7
1974 CHEVROLET IMPALA	514.6	519.5	95.0	105.4	91.5	99.9	.	67.8	.	82.3	.
	473.1	311.1	308.8	86.8	95.0	66.0	.	66.6	.	73.6	.
	.	.	.	101.6	.	.	.	.	.	.	.
AVE	494.0	415.3	201.9	97.9	93.2	82.9	.	67.2	.	77.9	.
1977 HONDA CIVIC 49 STATE	302.2	419.5	78.9	87.5	75.9	62.6	.	57.1	.	41.4	.
	293.6	202.6	246.4	87.9	71.5	75.4	.	49.2	.	46.0	.
AVE	297.9	311.0	162.7	87.7	73.7	69.0	.	53.2	.	43.7	.
1977 FORD LTD 49 STATE	245.5	202.4	118.2	98.2	111.0	93.1	120.3	99.4	114.8	88.4	112.1
	246.3	150.2	110.3	117.1	116.8	91.3	104.8	84.9	88.2	8.1	117.5
	224.1	.	.	.	.	.	.	.	.	.	.
AVE	238.6	176.3	114.3	107.7	113.9	92.2	112.6	92.1	101.5	48.3	114.8
1977 PLYMOUTH FURY 49S	232.5	127.7	63.4	69.8	22.0	67.5	.	37.4	.	26.8	.
	247.6	176.9	217.8	150.7	104.0	62.9	.	46.7	.	32.2	.
	.	.	.	105.6	66.8	.	.	.	.	.	.
AVE	240.0	152.3	140.6	108.7	64.3	65.2	.	42.0	.	29.5	.
1978 BUICK V6 TURBOCHARGE	529.6	262.8	148.3	102.5	84.1	63.8	73.5	33.6	37.5	27.6	48.9
	392.2	227.8	262.0	94.3	69.6	56.7	71.9	52.4	57.0	63.6	38.8
	442.9	.	.	.	.	.	.	.	.	.	.
AVE	454.9	245.3	205.2	98.4	76.9	60.3	72.7	43.0	47.2	45.6	43.8
1977 PLYMOUTH FURY CALIF	132.6	66.3	43.3	33.5	24.1	19.7	33.5	25.2	31.6	26.9	36.3
	132.4	60.2	43.2	37.2	53.7	18.1	27.6	22.2	47.8	35.4	52.6
	.	.	.	.	.	.	.	.	.	.	66.2
AVE	132.5	63.2	43.2	35.4	38.9	18.9	30.5	22.2	39.7	31.1	51.7
1978 CHEVROLET ST W-CALIF	165.7	48.7	25.9	24.9	25.4	18.7	23.3	21.1	21.6	30.7	40.5
	97.0	46.4	29.8	22.5	24.6	19.2	23.8	19.7	27.8	21.6	23.8
AVE	131.3	47.5	27.9	23.7	25.0	19.0	23.6	20.4	24.7	26.2	32.2
1978 FORD PINTO CAL 3 WAY	199.5	109.5	72.0	40.3	38.1	36.0	36.7	18.6	12.2	28.8	15.6
	212.0	157.4	90.1	52.0	30.9	20.8	21.0	12.3	15.1	22.4	14.0
	254.6	.	.	.	.	.	.	9.4	.	.	26.7
AVE	222.1	133.4	81.0	46.1	34.5	28.4	28.8	13.4	13.6	25.6	18.7
1978 VW RABBIT CAL FU-INJ	107.2	68.3	43.3	21.1	32.1	31.2	.	28.5	.	40.3	.
	102.7	55.7	36.6	40.4	37.5	33.3	.	41.6	.	44.9	.
AVE	105.0	62.0	39.9	30.7	34.8	32.2	.	35.1	.	42.6	.
1979 DODGE ASPEN CALIF.	293.8	193.3	99.7	37.1	21.7	14.8	20.8	17.2	13.2	20.0	35.6
	211.5	93.9	142.8	39.3	62.7	52.6	50.4	27.0	28.2	20.8	36.6
AVE	252.7	143.6	121.2	38.2	42.2	33.7	35.6	22.1	20.7	20.4	36.1
1980 MERCURY PROTOTYPE	.	178.2	88.6	43.3	20.1	23.2	22.6	32.2	34.1	49.9	24.8
	.	210.9	.	.	33.7	21.3	.	.	.	38.0	30.9
AVE	.	194.5	88.6	43.3	26.9	22.3	22.6	32.2	34.1	43.9	27.9
1980 BUICK REGAL PROTOTYP	.	85.5	63.6	36.5	30.8	26.1	27.8	25.7	25.9	23.0	26.0
	.	76.4	.	.	29.9	23.8	.	.	.	22.5	21.7
AVE	.	80.9	63.6	36.5	30.4	25.0	27.8	25.7	25.9	22.7	23.9
DATSUN PROTOTYPE	124.1	68.6	43.1	33.6	20.9	17.5	.	14.4	.	11.0	.
	102.2	67.6	44.6	32.8	23.8	25.4	.	12.4	.	13.0	.
	.	.	48.6	.	.	.	.	.	.	.	.
AVE	113.1	68.1	45.4	33.2	22.4	21.4	.	13.4	.	12.0	.

TABLE 89 GAS CHROMATOGRAPHIC ANALYSIS

STABILIZED FTP - BENZENE, MG/KM

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	56.3	31.8	24.7	42.9	56.3	41.5	30.5	56.0	58.9	75.0	91.4
	27.1	38.7	59.1	48.9	29.0	29.4	39.3	47.0	44.5	61.2	44.6
AVE	41.7	35.3	41.9	45.9	42.7	35.4	34.9	51.5	51.7	68.1	68.0
1974 CHEVROLET IMPALA	19.1	15.3	28.3	30.7	35.7	42.1	.	44.8	.	21.1	.
	17.2	18.8	27.8	42.4	47.6	39.6	.	43.6	.	43.8	.
	.	.	.	52.2	.	.	.	.	.	.	.
AVE	18.1	17.0	28.0	41.8	41.6	40.9	.	44.2	.	32.4	.
1977 HONDA CIVIC 49 STATE	58.5	62.5	21.0	24.2	29.0	29.4	.	28.6	.	35.4	.
	63.0	55.2	17.9	28.6	27.8	27.9	.	30.8	.	30.9	.
AVE	60.7	58.9	19.5	26.4	28.4	28.6	.	29.7	.	33.1	.
1977 FORD LTD 49 STATE	67.5	42.9	24.2	38.7	48.0	36.1	60.9	48.9	105.2	93.4	112.7
	62.6	37.8	31.4	37.9	57.9	44.9	79.2	36.2	81.3	86.4	121.9
	59.5	.	.	.	.	.	.	.	.	.	.
AVE	63.2	40.3	27.8	38.3	52.9	40.5	70.1	42.5	93.2	89.9	117.3
1977 PLYMOUTH FURY 495	33.9	15.7	5.1	9.3	2.4	6.5	.	6.3	.	46.0	.
	24.5	27.1	13.2	11.5	32.1	6.3	.	9.8	.	34.4	.
	.	.	.	11.8	6.1	.	.	.	.	.	.
AVE	29.2	21.4	9.2	10.9	13.5	6.4	.	8.0	.	40.2	.
1978 BUICK V6 TURBOCHARGE	3.5	2.8	2.9	3.0	4.4	3.2	2.7	3.0	6.0	13.2	15.3
	2.4	1.6	1.6	3.0	3.6	4.1	5.3	7.5	5.7	16.2	16.4
	3.2	.	.	.	.	.	.	.	.	.	.
AVE	3.0	2.2	2.2	3.0	4.0	3.6	4.0	5.3	5.8	14.7	15.8
1977 PLYMOUTH FURY CALIF	0.9	0.7	0.3	0.7	0.3	0.5	3.3	0.8	9.8	0.5	5.2
	0.5	0.0	0.6	2.6	3.2	0.4	2.7	3.0	3.1	4.3	28.3
	.	.	.	.	.	.	.	.	.	.	18.7
AVE	0.7	0.3	0.4	1.7	1.7	0.5	3.0	3.0	6.5	2.4	17.4
1978 CHEVROLET ST W-CALIF	2.3	1.9	1.9	0.5	1.1	0.9	0.8	0.8	1.6	2.6	10.7
	3.1	2.8	3.9	6.2	1.3	1.5	0.7	2.1	1.3	1.1	4.8
. AVE	2.7	2.3	2.9	3.4	1.2	1.2	0.8	1.4	1.4	1.8	7.7
1978 FORD PINTO CAL 3 WAY	4.5	6.0	2.2	3.8	3.8	9.1	7.5	4.3	3.2	3.7	5.1
	37.4	30.2	26.5	5.5	4.7	5.3	3.1	2.7	2.0	10.1	4.0
	31.8	.	.	.	.	.	.	1.8	.	.	8.2
AVE	24.6	18.1	14.4	4.7	4.3	7.2	5.3	2.9	2.6	6.9	5.7
1978 VW RABBIT CAL FU-INJ	16.5	4.6	5.1	5.0	8.3	14.7	.	17.2	.	32.9	.
	38.5	2.6	2.4	6.8	10.3	16.1	.	30.6	.	40.3	.
AVE	27.5	3.6	3.8	5.9	9.3	15.4	.	23.9	.	36.6	.
1979 DODGE ASPEN CALIF.	3.1	4.7	4.2	5.9	5.5	3.6	3.4	4.7	3.3	7.6	6.9
	3.3	3.9	3.7	6.2	5.0	4.4	4.5	3.5	5.0	6.0	8.2
AVE	3.2	4.3	3.9	6.0	5.2	4.0	4.0	4.1	4.1	6.8	7.5
1980 MERCURY PROTOTYPE	.	5.9	4.3	1.7	3.5	1.6	3.6	3.4	3.3	2.9	3.0
	.	3.4	.	.	2.3	4.7	.	.	.	2.7	1.7
AVE	.	4.7	4.3	1.7	2.9	3.1	3.6	3.4	3.3	2.8	2.3
1980 BUICK REGAL PROTOTYP	.	1.0	0.2	0.7	0.6	1.4	0.6	0.7	0.6	3.2	13.2
	.	1.3	.	.	0.6	2.9	.	.	.	2.4	11.7
AVE	.	1.1	0.2	0.7	0.6	2.1	0.6	0.7	0.6	2.8	12.5
DATSUN PROTOTYPE	1.0	1.8	1.9	3.1	1.4	2.8	.	2.4	.	6.2	.
	1.0	1.2	0.9	4.3	1.9	3.4	.	3.3	.	5.2	.
	.	.	3.4	.	.	.	.	.	.	.	.
AVE	1.0	1.5	2.1	3.7	1.7	3.1	.	2.8	.	5.7	.

TABLE 90 GAS CHROMATOGRAPHIC ANALYSIS

HOT TRANSIENT FTP - BENZENE, MG/KM

TEMPERATURE F (C)		0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA		48.7	35.4	34.1	58.2	51.9	47.9	50.0	62.8	64.7	77.1	84.6
		31.0	18.6	25.6	39.6	34.4	36.9	49.2	50.1	45.2	71.9	53.0
	AVE	39.9	27.0	29.9	48.9	43.2	42.4	49.6	56.5	55.0	74.5	68.8
1974 CHEVROLET IMPALA		34.9	25.8	34.0	51.9	51.7	69.4	.	66.9	.	90.7	.
		32.5	34.0	29.1	50.1	58.9	63.5	.	64.0	.	73.2	.
		.	.	.	46.3	.	.	.	.	.	.	.
	AVE	33.7	29.9	31.5	49.4	55.3	66.4	.	65.4	.	82.0	.
1977 HONDA CIVIC 49 STATE		40.1	37.1	23.8	32.5	46.1	34.9	.	34.9	.	34.6	.
		39.3	27.8	27.4	39.9	33.0	31.3	.	33.7	.	36.1	.
	AVE	39.7	32.4	25.6	36.2	39.6	33.1	.	34.3	.	35.3	.
1977 FORD LTD 49 STATE		59.6	49.8	47.7	59.9	65.7	66.4	81.2	65.5	97.3	95.2	128.1
		53.6	46.1	51.7	58.1	72.0	78.6	86.6	66.9	92.2	102.9	125.0
		61.3	.	.	.	.	.	.	.	.	.	.
	AVE	58.2	48.0	49.7	59.0	68.9	72.5	83.9	66.2	94.8	99.0	126.6
1977 PLYMOUTH FURY 49S		31.0	18.2	10.0	16.4	6.2	20.2	.	18.9	.	44.3	.
		19.0	24.9	18.7	14.4	22.1	14.8	.	20.2	.	44.4	.
		.	.	.	15.2	14.4	.	.	.	.	.	.
	AVE	25.0	21.6	14.4	15.3	14.2	17.5	.	19.6	.	44.3	.
1978 BUICK V6 TURBOCHARGE		26.4	17.3	8.5	11.9	11.7	11.5	18.1	18.5	28.6	77.7	107.6
		157.2	9.0	13.8	15.0	17.3	26.3	18.9	25.8	32.7	46.9	67.7
		124.8	.	.	.	.	.	.	.	.	.	.
	AVE	102.8	13.1	11.2	13.4	14.5	18.9	18.5	22.1	30.6	62.3	87.7
1977 PLYMOUTH FURY CALIF		4.0	4.3	4.9	22.2	9.7	13.6	17.9	11.9	20.6	23.3	31.6
		6.2	3.0	2.3	13.9	12.1	14.2	15.9	7.2	20.3	26.3	50.9
		.	.	.	.	.	.	.	.	.	.	54.4
	AVE	5.1	3.7	3.6	18.1	10.9	13.9	16.9	7.2	20.4	24.8	45.6
1978 CHEVROLET ST W-CALIF		4.5	3.0	3.1	2.4	3.1	2.9	4.9	3.8	7.6	7.5	15.3
		3.7	6.1	3.6	2.9	3.0	3.5	2.7	4.7	3.1	12.8	25.2
	AVE	4.1	4.5	3.3	2.6	3.0	3.2	3.8	4.2	5.3	10.2	20.2
1978 FORD PINTO CAL 3 WAY		6.1	4.1	3.7	7.0	8.4	15.5	11.8	9.2	5.6	8.0	11.6
		7.8	19.1	14.7	6.7	6.6	7.5	5.8	3.3	4.3	14.8	6.8
		4.0	.	.	.	.	.	.	2.6	.	.	12.7
	AVE	6.0	11.6	9.2	6.9	7.5	11.5	8.8	5.0	5.0	11.4	10.4
1978 VW RABBIT CAL FU-INJ		13.7	11.0	11.1	8.9	20.2	27.9	.	27.5	.	42.0	.
		15.7	10.7	10.7	16.8	22.7	25.7	.	36.2	.	41.4	.
	AVE	14.7	10.9	10.9	12.8	21.5	26.8	.	31.9	.	41.7	.
1979 DODGE ASPEN CALIF.		5.3	4.5	6.7	7.1	7.8	8.6	11.0	10.9	10.0	17.9	24.7
		4.7	6.6	8.8	13.9	11.9	12.7	12.5	14.3	16.7	16.3	21.9
	AVE	5.0	5.5	7.8	10.5	9.9	10.7	11.7	12.6	13.3	17.1	23.3
1980 MERCURY PROTOTYPE		.	14.5	16.8	11.1	10.9	66.1	11.8	16.3	13.4	22.3	13.1
		.	11.0	.	.	8.9	16.3	.	.	.	14.1	11.6
	AVE	.	12.7	16.8	11.1	9.9	41.2	11.8	16.3	13.4	18.2	12.3
1980 BUICK REGAL PROTOTYP		.	10.5	6.4	9.5	10.4	6.4	8.3	5.4	8.0	19.5	23.1
		.	10.8	.	.	12.0	8.8	.	.	.	13.9	26.9
	AVE	.	10.7	6.4	9.5	11.2	7.6	8.3	5.4	8.0	16.7	25.0
DATSUN PROTOTYPE		6.1	3.9	3.8	6.7	3.8	4.7	.	5.6	.	13.6	.
		6.4	3.8	2.6	5.6	3.8	6.6	.	5.3	.	10.3	.
		.	.	3.4	.	.	.	.	.	.	.	.
	AVE	6.2	3.9	3.3	6.1	3.8	5.6	.	5.5	.	12.0	.

FUEL ECONOMY

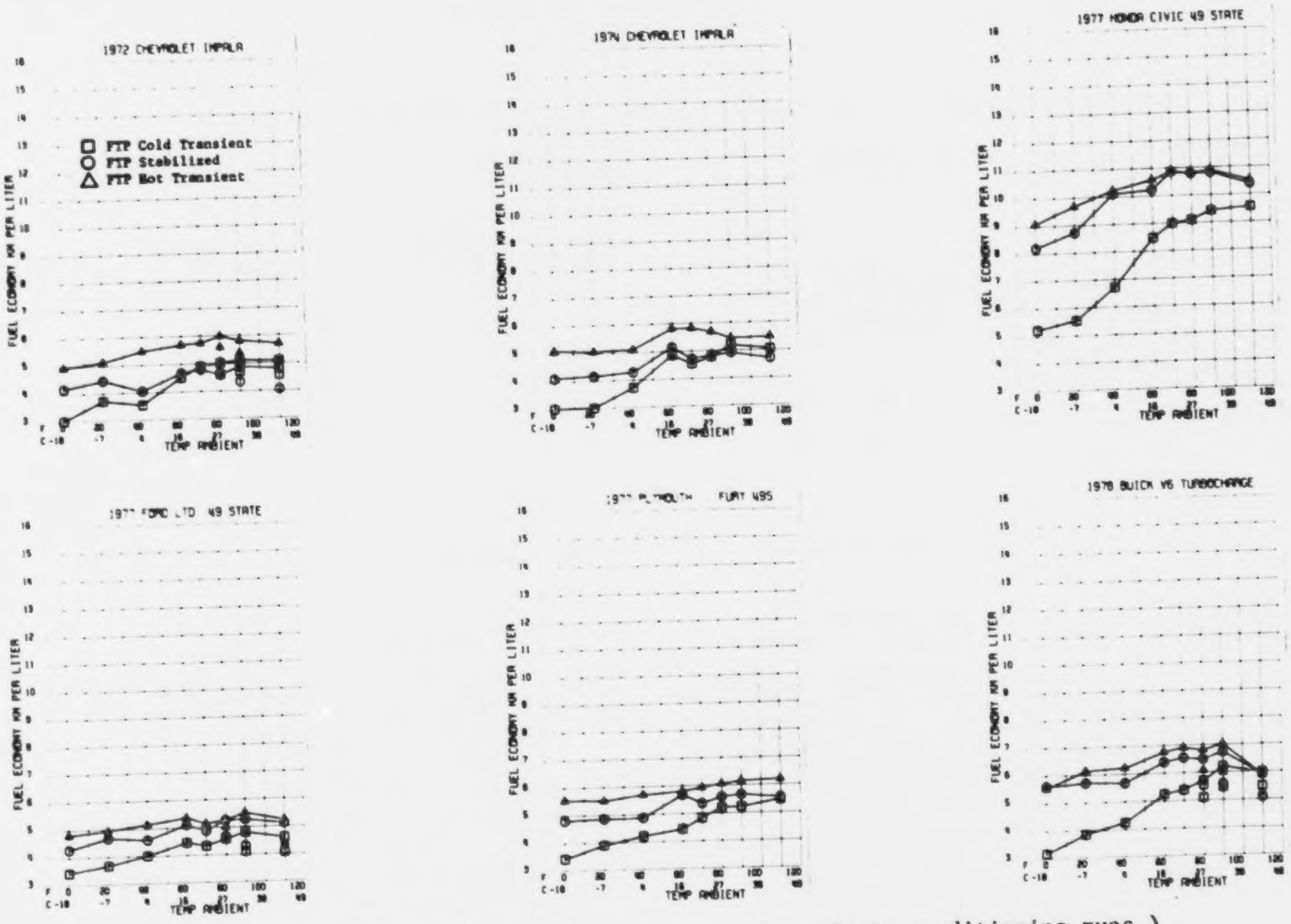
Fuel economy results were calculated using the carbon balance method which is based on the total carbon consumed. The fuel economies obtained by all of the various test procedures are discussed in the sections that follow. Figure 15 illustrates the fuel economies obtained with the three phases of the FTP while Figure 16 shows the fuel economies for the composite FTP plus the other procedures run.

Federal Test Procedure-Cold Transient Phase-Fuel Economy--

Table 91 shows the fuel economy in kilometers per liter (km/l) for

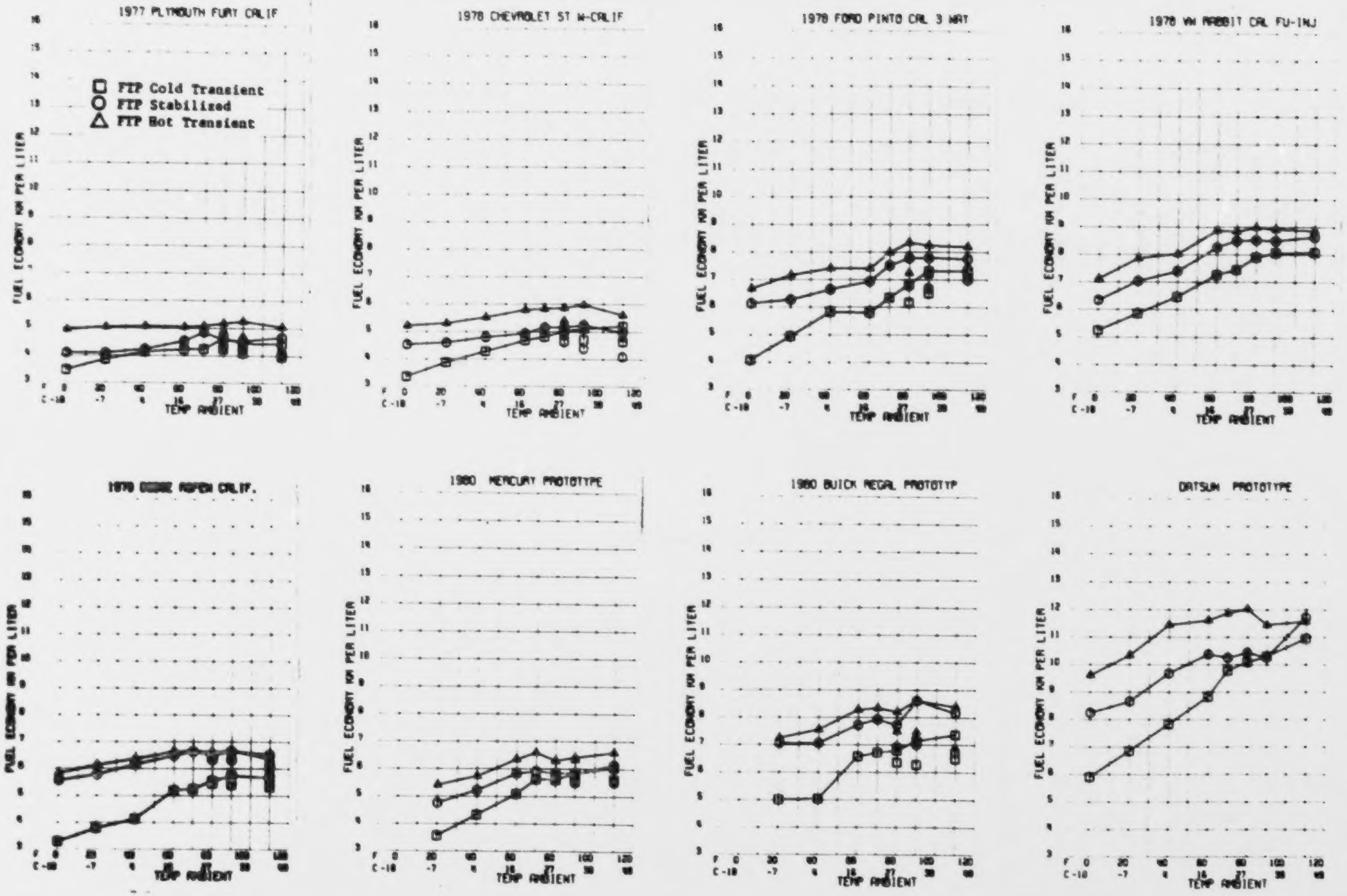
TABLE 91 F T P COLD TRANSIENT - FUEL ECONOMY KM/L

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	2.80	3.81	4.04	4.87	5.18	5.12	4.74	5.17	4.83	5.35	4.72
	2.68	3.59	3.04	4.15	4.60	4.90	4.46	5.02	4.55	4.79	4.40
AVE	2.74	3.70	3.47	4.48	4.86	5.00	4.59	5.10	4.68	5.06	4.56
1974 CHEVROLET IMPALA	2.49	2.51	4.01	5.59	4.52	4.59	.	5.12	.	4.97	.
	2.71	2.87	3.41	4.41	4.53	4.96	.	5.24	.	5.11	.
	.	.	.	4.24	.	.	.	.	.	.	.
AVE	2.59	2.68	3.66	4.75	4.52	4.77	.	5.18	.	5.04	.
1977 HONDA CIVIC 49 STATE	5.18	5.40	7.39	8.38	8.88	9.11	.	9.42	.	9.97	.
	5.23	5.66	5.72	8.57	9.09	9.09	.	9.43	.	9.11	.
AVE	5.20	5.53	6.56	8.47	8.98	9.10	.	9.42	.	9.52	.
1977 FORD LTD 49 STATE	3.21	3.63	3.94	4.51	4.26	4.71	4.39	4.64	4.04	4.56	4.12
	3.56	3.69	4.06	4.38	4.39	4.39	4.76	4.93	4.15	4.61	3.98
	3.47	.	.	.	.	.	.	.	.	.	.
AVE	3.41	3.66	4.00	4.44	4.32	4.55	4.57	4.78	4.09	4.59	4.05
1977 PLYMOUTH FURY 49S	3.41	3.98	4.50	.	4.87	5.42	.	5.31	.	5.34	.
	3.43	3.80	3.81	4.40	4.89	4.96	.	5.10	.	5.57	.
	.	.	.	4.66	4.71	.	.	.	.	.	.
AVE	3.42	3.89	4.16	4.53	4.82	5.18	.	5.20	.	5.45	.
1978 BUICK V6 TURBOCHARGE	.	3.76	4.36	5.18	5.32	5.68	4.91	6.23	5.57	6.43	5.43
	3.28	3.92	4.08	5.26	5.43	5.70	5.24	6.19	5.35	5.51	5.52
	3.18	.	.	.	.	.	.	.	.	.	.
AVE	3.23	3.84	4.22	5.22	5.37	5.69	5.07	6.21	5.46	5.94	5.47
1977 PLYMOUTH FURY CALIF	3.47	3.87	4.16	4.14	4.32	4.89	4.16	4.40	4.19	4.50	4.26
	3.47	3.82	4.10	4.30	4.15	4.37	4.28	4.47	3.98	4.35	3.90
	.	.	.	.	.	.	.	.	.	.	3.71
AVE	3.47	3.84	4.13	4.22	4.23	4.62	4.22	4.47	4.08	4.43	3.95
1978 CHEVROLET ST W-CALIF	3.28	3.82	4.29	4.68	4.75	5.01	4.71	5.15	4.76	5.23	4.46
	3.42	3.92	4.25	4.67	4.85	5.03	4.61	5.07	4.65	5.16	4.80
AVE	3.35	3.87	4.27	4.67	4.80	5.02	4.66	5.11	4.70	5.19	4.62
1978 FORD PINTO CAL 3 WAY	4.28	4.89	6.50	5.74	6.20	6.55	5.70	7.29	6.44	7.26	6.94
	4.23	4.98	5.13	5.82	6.46	7.10	6.57	7.22	6.54	7.36	7.80
	3.72	.	.	.	.	.	.	7.41	.	.	6.40
AVE	4.06	4.93	5.74	5.78	6.33	6.81	6.14	7.31	6.49	7.31	7.00
1978 VW RABBIT CAL FU-INJ	5.26	5.66	6.45	7.23	7.40	7.87	.	8.13	.	8.13	.
	5.21	6.02	6.46	7.28	7.47	7.93	.	7.97	.	8.01	.
AVE	5.23	5.83	6.45	7.25	7.43	7.90	.	8.05	.	8.07	.
1979 DODGE ASPEN CALIF.	3.21	3.65	4.35	5.20	5.40	5.67	5.61	5.80	5.52	5.58	5.29
	3.35	3.90	3.89	5.16	5.08	5.41	5.26	5.69	5.28	5.72	5.32
AVE	3.28	3.77	4.11	5.18	5.24	5.54	5.43	5.74	5.40	5.65	5.31
1980 MERCURY PROTOTYPE	.	3.50	4.31	5.08	5.67	5.69	5.58	5.82	5.57	6.06	5.62
	.	3.61	.	.	5.57	5.53	.	.	.	6.02	5.63
AVE	.	3.55	4.31	5.08	5.62	5.61	5.58	5.82	5.57	6.04	5.62
1980 BUICK REGAL PROTOTYP	.	4.92	5.02	6.57	6.72	6.80	6.34	7.14	6.26	7.53	6.51
	.	5.07	.	.	6.71	6.76	.	.	.	7.18	6.45
AVE	.	5.00	5.02	6.57	6.71	6.78	6.34	7.14	6.26	7.35	6.46
DATSUN PROTOTYPE	5.87	6.80	8.02	8.67	9.80	10.10	.	10.38	.	10.79	.
	5.92	6.90	.	8.98	9.77	10.07	.	10.23	.	11.11	.
	.	.	7.83	.	.	.	.	.	.	.	.
AVE	5.89	6.85	7.92	8.82	9.78	10.09	.	10.30	.	10.95	.



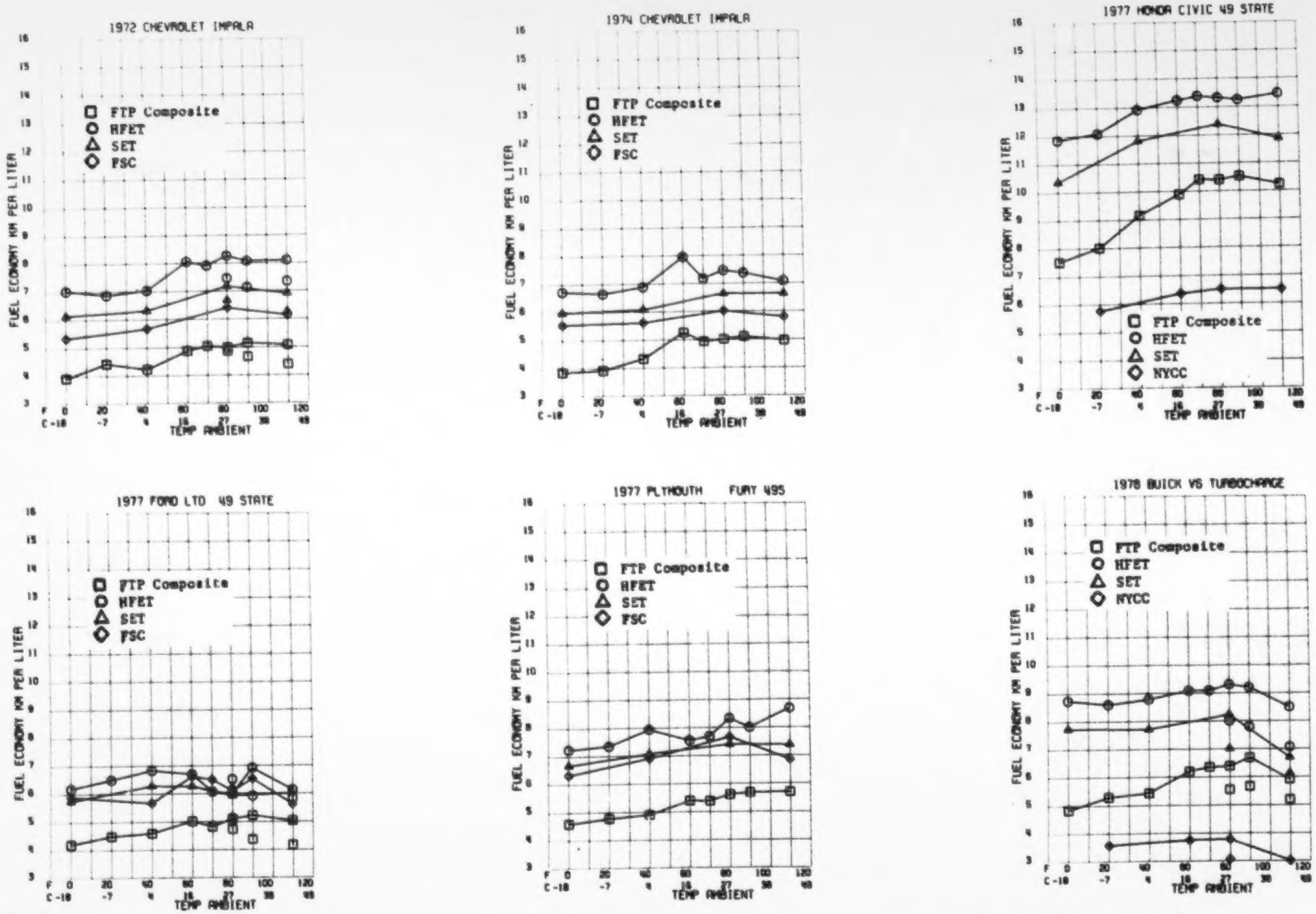
(Data points not connected by a line are the results of air conditioning runs.)

Figure 15. Effect of ambient temperature on fuel economies for the three phases of the FTP.



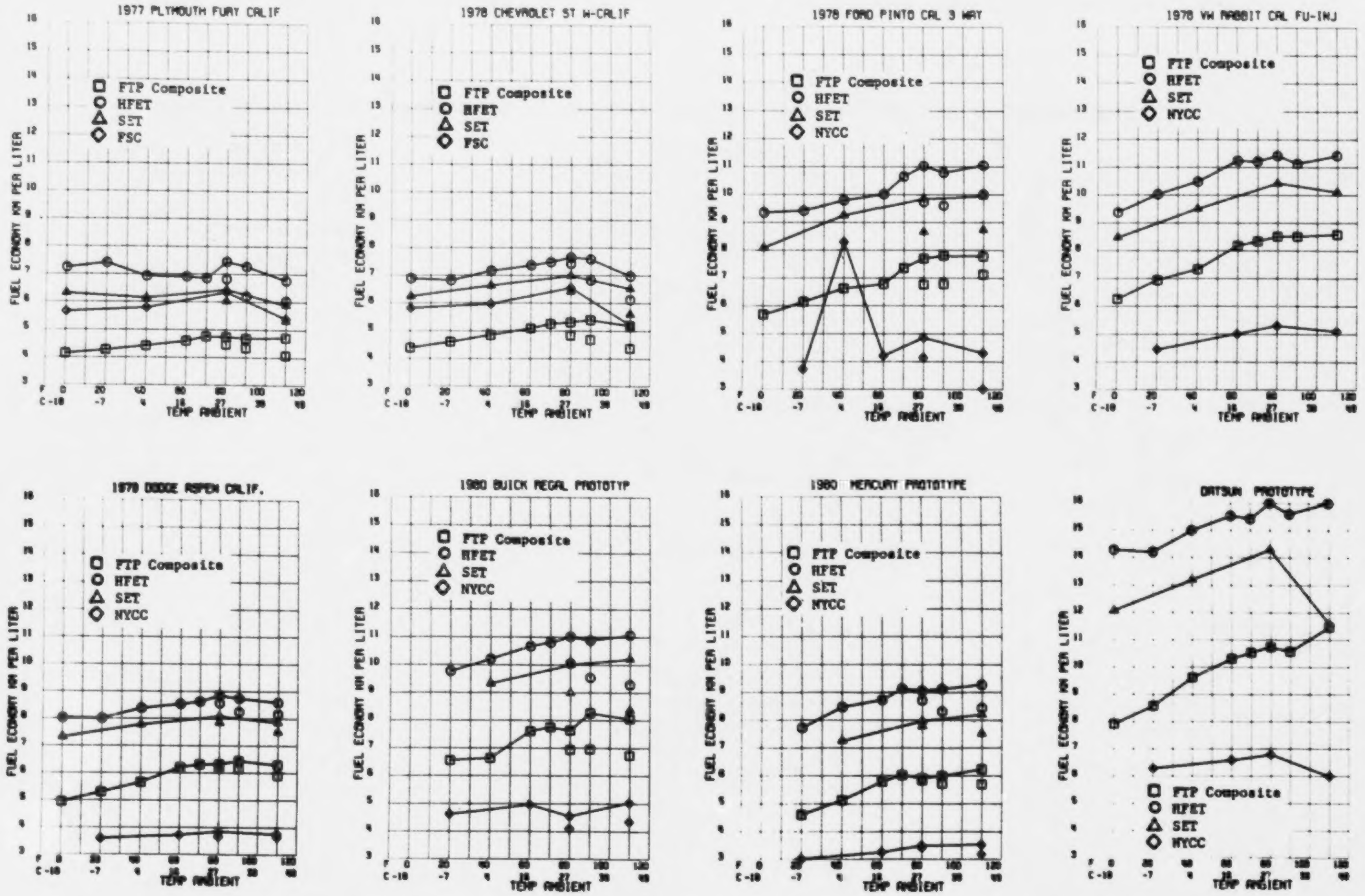
(Data points not connected by a line are the results of air conditioning runs.)

Figure 15. (continued)



(Data points not connected by a line are the results of air conditioning runs.)

Figure 16. Effect of ambient temperature on fuel economies for different test cycles.



(Data points not connected by a line are the results of air conditioning runs.)

Figure 16. (continued)

the cold transient phase of the FTP. This phase of the procedure gave very poor economy with the poorest economy occurring at 0°F (-18°C). Air conditioning operation reduced fuel economy. The lighter cars had the best economy in general. Repeatability was considered to be satisfactory.

Federal Test Procedure-Stabilized Phase-Fuel Economy--

Table 92 lists the fuel economies for the stabilized phase of the FTP. The fuel economy improved substantially over that obtained during the cold transient phase of the FTP. Economy generally improved with ambient temperature unless the air conditioners were on. The Honda and Datsun gave the best economies.

TABLE 92 F T P STABILIZED - FUEL ECONOMY KM/L

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	4.20	4.56	4.32	4.66	4.90	4.15	4.69	4.83	4.33	4.91	4.18
	4.13	4.34	3.76	4.65	4.66	5.03	4.58	4.91	4.33	4.67	3.88
AVE	4.17	4.44	4.02	4.66	4.78	4.55	4.63	4.87	4.33	4.79	4.03
1974 CHEVROLET IMPALA	3.85	3.97	4.25	6.32	4.74	4.80	.	4.86	.	4.59	.
	4.37	4.34	4.30	4.60	4.67	4.81	.	4.95	.	4.80	.
	.	.	.	4.50	.	.	.	.	.	.	.
AVE	4.09	4.15	4.28	5.02	4.71	4.81	.	4.90	.	4.69	.
1977 HONDA CIVIC 49 STATE	8.16	8.86	10.06	10.24	10.89	10.81	.	10.73	.	11.02	.
	8.22	8.58	10.15	10.20	10.84	10.77	.	10.91	.	9.75	.
AVE	8.19	8.72	10.11	10.22	10.86	10.79	.	10.82	.	10.35	.
1977 FORD LTD 49 STATE	4.13	4.65	4.50	5.29	4.93	5.41	4.76	5.26	4.21	5.11	4.14
	4.34	4.68	4.65	4.90	4.80	5.07	4.51	5.26	4.40	5.09	4.05
	4.34	.	.	.	.	.	.	.	.	.	.
AVE	4.27	4.66	4.58	5.09	4.86	5.23	4.64	5.26	4.30	5.10	4.09
1977 PLYMOUTH FURY 49S	4.75	4.73	4.87	6.09	5.39	5.62	.	5.60	.	5.40	.
	4.85	4.96	4.85	5.06	5.33	5.53	.	5.66	.	5.69	.
	.	.	.	5.84	5.34	.	.	.	.	.	.
AVE	4.80	4.84	4.86	5.63	5.35	5.57	.	5.64	.	5.54	.
1978 BUICK V6 TURBOCHARGE	5.71	5.68	5.72	6.59	6.73	6.62	5.42	7.02	5.70	6.31	5.11
	5.63	5.73	5.63	6.19	6.34	6.33	5.60	6.44	5.44	5.50	5.01
	5.47	.	.	.	.	.	.	.	.	.	.
AVE	5.60	5.71	5.67	6.39	6.53	6.47	5.51	6.72	5.57	5.86	5.06
1977 PLYMOUTH FURY CALIF	4.12	4.06	4.24	4.61	5.39	4.51	4.46	4.51	4.32	4.57	4.29
	4.06	4.12	4.20	4.45	4.30	4.63	4.24	4.53	4.19	4.76	3.94
	.	.	.	.	.	.	.	.	.	.	3.86
AVE	4.09	4.09	4.22	4.53	4.78	4.57	4.35	4.53	4.25	4.66	4.02
1978 CHEVROLET ST W-CALIF	4.43	4.62	4.82	4.88	5.15	5.16	4.63	5.26	4.39	4.97	4.00
	4.63	4.57	4.75	4.98	5.16	5.15	4.62	5.20	4.36	4.97	4.17
AVE	4.53	4.59	4.79	4.93	5.16	5.15	4.62	5.24	4.38	4.97	4.08
1978 FORD PINTO CAL 3 WAY	6.32	6.38	6.62	6.87	7.27	7.52	6.60	7.57	6.66	7.80	6.93
	6.23	6.15	6.64	7.00	7.76	8.03	6.95	7.62	6.72	7.71	6.87
	5.86	.	.	.	.	.	.	8.21	.	.	7.18
AVE	6.13	6.26	6.63	6.93	7.51	7.77	6.77	7.77	6.69	7.75	6.99
1978 VW RABBIT CAL FU-INJ	6.50	6.94	7.56	8.28	8.42	8.43	.	8.57	.	8.82	.
	6.17	7.10	7.21	8.22	8.56	8.62	.	8.41	.	8.44	.
AVE	6.33	7.02	7.38	8.25	8.49	8.52	.	8.49	.	8.62	.
1979 DODGE ASPEN CALIF.	5.63	5.57	6.28	6.50	6.71	6.59	6.38	6.66	6.34	6.50	5.99
	5.50	6.00	6.04	6.48	6.57	6.40	6.30	6.63	6.30	6.56	6.26
AVE	5.57	5.78	6.16	6.49	6.64	6.50	6.34	6.64	6.32	6.53	6.12
1980 MERCURY PROTOTYPE	.	4.68	5.21	5.83	5.90	5.89	5.70	5.85	5.50	6.12	5.53
	.	4.83	.	.	5.93	5.80	.	.	.	6.13	5.48
AVE	.	4.75	5.21	5.83	5.92	5.85	5.70	5.85	5.50	6.13	5.50
1980 BUICK REGAL PROTOTYP	.	7.01	7.06	7.73	7.87	7.67	6.92	8.60	6.99	8.31	6.57
	.	7.09	.	.	7.97	7.78	.	.	.	8.01	6.91
AVE	.	7.05	7.06	7.73	7.92	7.72	6.92	8.60	6.99	8.16	6.73
DATSUN PROTOTYPE	8.23	8.83	9.91	10.55	10.31	10.45	.	10.59	.	13.04	.
	8.24	8.46	9.40	10.21	10.18	10.47	.	9.93	.	10.40	.
	.	.	9.73	.	.	.	.	.	.	.	.
AVE	8.24	8.64	9.68	10.37	10.24	10.44	.	10.25	.	11.57	.

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Federal Test Procedure-Hot Transient Phase-Fuel Economy--

The fuel economies for the hot transient phase of the FTP are given in Table 93. Generally, the fuel economies for this phase were a great improvement over those obtained during the cold transient phase and also better than those obtained during the stabilized phase. Again, fuel economy improved with ambient temperature unless the air conditioners were on.

TABLE 93 F T P HOT TRANSIENT - FUEL ECONOMY KM/L

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	4.93	5.17	5.30	5.77	5.94	6.04	5.92	5.82	5.58	5.95	5.52
	4.93	5.06	5.66	5.61	5.55	5.92	5.24	5.78	5.13	5.44	4.55
AVE	4.93	5.11	5.47	5.69	5.73	5.98	5.56	5.80	5.35	5.68	4.99
1974 CHEVROLET IMPALA	4.91	5.01	4.95	7.07	6.19	6.00	.	5.42	.	5.29	.
	5.30	5.08	5.22	5.14	5.45	5.30	.	5.45	.	5.64	.
	.	.	.	5.03	.	.	.	.	.	.	.
AVE	5.10	5.04	5.08	5.69	5.79	5.66	.	5.43	.	5.46	.
1977 HONDA CIVIC 49 STATE	8.96	9.50	10.16	10.59	10.74	10.63	.	10.81	.	10.82	.
	9.14	9.88	10.29	10.57	10.97	10.96	.	10.99	.	10.20	.
AVE	9.05	9.68	10.22	10.58	10.85	10.79	.	10.90	.	10.50	.
1977 FORD LTD 49 STATE	4.76	4.85	5.14	5.39	5.19	5.35	5.10	5.54	4.62	5.32	4.33
	4.79	5.03	5.13	5.30	5.06	5.14	4.86	5.45	4.82	5.12	4.42
	4.84	.	.	.	.	.	.	.	.	.	.
AVE	4.80	4.94	5.13	5.35	5.12	5.24	4.98	5.49	4.71	5.22	4.38
1977 PLYMOUTH FURY 495	5.56	5.51	5.54	5.88	5.75	6.18	.	6.25	.	6.06	.
	5.51	5.52	5.86	5.69	5.97	5.91	.	6.02	.	6.33	.
	.	.	.	5.83	6.07	.	.	.	.	.	.
AVE	5.54	5.51	5.69	5.80	5.93	6.04	.	6.13	.	6.19	.
1978 BUICK V6 TURBOCHARGE	6.09	6.11	6.29	6.86	7.01	6.99	5.82	7.12	6.04	5.96	5.11
	5.17	6.17	6.14	6.64	6.80	6.61	6.32	6.91	5.92	5.76	5.32
	5.30	.	.	.	.	.	.	.	.	.	.
AVE	5.49	6.14	6.21	6.75	6.90	6.79	6.06	7.01	5.98	5.86	5.21
1977 PLYMOUTH FURY CALIF	4.87	4.95	5.04	4.88	5.00	5.17	4.88	5.22	4.71	4.97	4.51
	4.99	5.11	5.09	5.20	5.15	5.17	4.89	5.26	4.66	5.11	4.09
	.	.	.	.	.	.	.	.	.	.	4.07
AVE	4.93	5.03	5.07	5.03	5.07	5.17	4.88	5.26	4.68	5.04	4.22
1978 CHEVROLET ST W-CALIF	5.11	5.34	5.62	5.77	5.82	5.85	5.41	6.02	5.07	5.61	4.83
	5.31	5.26	5.41	5.81	5.85	5.88	5.38	5.93	5.45	5.59	4.66
AVE	5.21	5.30	5.51	5.79	5.84	5.86	5.39	5.98	5.26	5.60	4.74
1978 FORD PINTO CAL 3 WAY	6.82	7.18	7.33	7.34	7.76	8.26	6.75	7.88	6.99	8.04	7.41
	6.79	7.13	7.48	7.47	8.21	8.43	7.71	8.31	7.33	8.34	7.41
	6.39	.	.	.	.	.	.	8.50	.	.	7.60
AVE	6.66	7.16	7.40	7.40	7.98	8.34	7.20	8.22	7.16	8.18	7.47
1978 VW RABBIT CAL FU-INJ	7.13	7.87	8.03	8.95	8.71	8.90	.	9.07	.	8.99	.
	7.09	7.84	8.00	8.79	8.96	9.05	.	8.75	.	8.74	.
AVE	7.11	7.85	8.01	8.87	8.83	8.97	.	8.91	.	8.86	.
1979 DODGE ASPEN CALIF.	5.82	6.09	6.57	6.66	6.76	6.65	6.52	6.74	6.58	6.36	5.85
	5.83	6.19	6.17	6.61	6.56	6.59	6.41	6.60	6.25	6.37	6.09
AVE	5.83	6.14	6.36	6.64	6.66	6.62	6.46	6.67	6.41	6.36	5.97
1980 MERCURY PROTOTYPE	.	5.26	5.72	6.35	6.60	6.14	6.30	6.41	6.34	6.67	6.13
	.	5.56	.	.	6.59	6.44	.	.	.	6.53	6.20
AVE	.	5.41	5.72	6.35	6.60	6.29	6.30	6.41	6.34	6.60	6.16
1980 BUICK REGAL PROTOTYP	.	7.25	7.55	8.27	8.45	8.22	7.48	8.60	7.45	8.61	6.63
	.	7.22	.	.	8.21	8.18	.	.	.	8.15	7.13
AVE	.	7.24	7.55	8.27	8.33	8.20	7.48	8.60	7.45	8.38	6.87
DATSUN PROTOTYPE	9.61	10.33	11.13	11.78	12.05	12.05	.	11.74	.	11.50	.
	9.61	10.34	12.31	11.45	11.70	12.00	.	11.15	.	11.64	.
	.	.	10.89	.	.	.	.	.	.	.	.
AVE	9.61	10.34	11.41	11.61	11.87	12.02	.	11.44	.	11.57	.

Federal Test Procedure-Composite-Fuel Economy--

Table 94 gives the fuel economy results for the composite FTP. Combining the results of the three phases gave fuel economies that were better than those obtained during the cold transient phase but not as good as was achieved during the other two phases. Again, the Datsun had the best fuel economy, followed by the Honda and the VW.

TABLE 94 F T P COMPOSITE - FUEL ECONOMY KM/L

TEMPERATURE F	0 (C)(-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	3.95	4.52	4.40	4.96	5.18	4.71	4.98	5.14	4.72	5.25	4.59
	3.86	4.32	3.98	4.75	4.86	5.21	4.71	5.14	4.57	4.88	4.15
AVE	3.91	4.42	4.19	4.86	5.02	4.96	4.84	5.14	4.64	5.06	4.36
1974 CHEVROLET IMPALA	3.65	3.74	4.37	6.41	5.01	5.03	.	5.05	.	4.84	.
	4.05	4.08	4.27	4.73	4.83	4.98	.	5.13	.	5.07	.
	.	.	.	4.57	.	.	.	.	.	.	.
AVE	3.84	3.90	4.32	5.12	4.92	5.00	.	5.09	.	4.95	.
1977 HONDA CIVIC 49 STATE	7.46	7.97	9.49	9.88	10.37	10.37	.	10.45	.	10.73	.
	7.55	8.02	8.79	9.91	10.46	10.42	.	10.59	.	9.72	.
AVE	7.50	8.00	9.13	9.89	10.42	10.39	.	10.52	.	10.20	.
1977 FORD LTD 49 STATE	4.04	4.44	4.52	5.13	4.84	5.23	4.77	5.19	4.27	5.04	4.18
	4.26	4.51	4.63	4.88	4.77	4.93	4.65	5.24	4.45	4.99	4.13
	4.24	.	.	.	.	.	.	.	.	.	.
AVE	4.18	4.48	4.58	5.01	4.81	5.08	4.71	5.21	4.36	5.02	4.16
1977 PLYMOUTH FURY 495	4.56	4.73	4.97	5.51	5.17	5.71	.	5.70	.	5.55	.
	4.60	4.79	4.80	5.06	5.19	5.49	.	5.64	.	5.83	.
	.	.	.	5.55	5.37	.	.	.	.	.	.
AVE	4.58	4.76	4.88	5.37	5.17	5.60	.	5.67	.	5.69	.
1978 BUICK V6 TURBOCHARGE	4.91	5.23	5.51	6.31	6.45	6.49	5.40	6.87	5.76	6.23	5.18
	4.81	5.33	5.33	6.08	6.24	6.26	5.69	6.51	5.54	5.57	5.19
	4.73	.	.	.	.	.	.	.	.	.	.
AVE	4.81	5.28	5.42	6.19	6.34	6.38	5.55	6.68	5.65	5.88	5.18
1977 PLYMOUTH FURY CALIF	4.13	4.23	4.41	4.57	5.03	4.75	4.50	4.66	4.39	4.66	4.34
	4.12	4.28	4.39	4.60	4.47	4.71	4.41	4.70	4.26	4.76	3.97
	.	.	.	.	.	.	.	.	.	.	3.88
AVE	4.13	4.25	4.40	4.58	4.73	4.73	4.45	4.70	4.32	4.71	4.06
1978 CHEVROLET ST W-CALIF	4.26	4.59	4.89	5.05	5.22	5.30	4.83	5.43	4.64	5.19	4.29
	4.46	4.58	4.79	5.11	5.26	5.30	4.80	5.35	4.67	5.17	4.41
AVE	4.36	4.58	4.84	5.08	5.24	5.30	4.82	5.39	4.65	5.18	4.35
1978 FORD PINTO CAL 3 WAY	5.87	6.18	6.77	6.72	7.14	7.48	6.45	7.57	6.70	7.74	7.05
	5.80	6.09	6.45	6.83	7.56	7.92	7.06	7.70	6.84	7.79	7.18
	5.34	.	.	.	.	.	.	8.11	.	.	7.11
AVE	5.66	6.13	6.61	6.77	7.35	7.69	6.74	7.79	6.77	7.77	7.12
1978 VW RABBIT CAL FU-INJ	6.34	6.84	7.42	8.20	8.26	8.43	.	8.61	.	8.71	.
	6.16	7.02	7.23	8.15	8.41	8.58	.	8.41	.	8.43	.
AVE	6.25	6.93	7.32	8.18	8.34	8.50	.	8.51	.	8.57	.
1979 DODGE ASPEN CALIF.	4.92	5.13	5.82	6.22	6.41	6.39	6.24	6.48	6.21	6.25	5.80
	4.93	5.45	5.46	6.19	6.20	6.22	6.08	6.40	6.05	6.32	6.00
AVE	4.92	5.28	5.63	6.21	6.30	6.30	6.16	6.44	6.13	6.29	5.90
1980 MERCURY PROTOTYPE	.	4.50	5.11	5.78	6.02	5.92	5.82	5.99	5.71	6.25	5.70
	.	4.67	.	.	6.02	5.90	.	.	.	6.21	5.68
AVE	.	4.58	5.11	5.78	6.02	5.91	5.82	5.99	5.71	6.23	5.69
1980 BUICK REGAL PROTOTYP	.	6.50	6.62	7.59	7.74	7.61	6.93	8.26	6.94	8.21	6.57
	.	6.59	.	.	7.73	7.64	.	.	.	7.86	6.87
AVE	.	6.54	6.62	7.59	7.74	7.63	6.93	8.26	6.94	8.04	6.72
DATSUN PROTOTYPE	7.89	8.64	9.73	10.39	10.61	10.76	.	10.83	.	12.09	.
	7.91	8.49	9.56	10.22	10.46	10.73	.	10.29	.	10.85	.
	.	.	9.53	.	.	.	.	.	.	.	.
AVE	7.90	8.57	9.61	10.30	10.54	10.75	.	10.56	.	11.44	.

Highway Fuel Economy Test-Fuel Economy--

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This procedure, with results given in Table 95, should give good fuel economy since it approaches constant speed operation. The effect of having run the SET test first at 0°F (-18°C), 40°F (4°C) and 80°F (27°C) generally shows an economy improvement over those at 20°F (-7°C) and 90°F (32°C). The same effect was not observed when comparing results at 40 and 60°F (4 and 16°C) but this may have been the result of the fuel change. Again, air conditioner operation reduced fuel economy.

TABLE 95 HIGHWAY FUEL ECONOMY TEST - FUEL ECONOMY KM/L

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	7.10	6.95	7.15	8.59	8.49	8.73	7.82	8.47	7.52	8.55	8.31
	6.77	6.79	6.92	7.52	7.32	7.79	7.08	7.66	6.73	7.65	6.37
AVE	7.02	6.87	7.03	8.02	7.86	8.24	7.43	8.04	7.10	8.07	7.21
1974 CHEVROLET IMPALA	6.57	6.60	6.76	9.67	7.41	7.36	.	7.47	.	7.00	.
	6.89	6.70	7.00	7.26	6.93	7.58	.	7.27	.	7.14	.
	.	.	.	6.92	.	.	.	.	.	.	.
AVE	6.72	6.65	6.88	7.78	7.17	7.47	.	7.37	.	7.07	.
1977 HONDA CIVIC 49 STATE	11.80	11.99	12.85	13.11	13.14	13.27	.	13.24	.	13.44	.
	11.91	12.18	12.97	13.36	13.62	13.37	.	13.25	.	13.47	.
AVE	11.86	12.08	12.91	13.23	13.38	13.32	.	13.24	.	13.46	.
1977 FORD LTD 49 STATE	6.12	6.18	6.75	6.47	6.08	5.84	6.69	6.62	5.61	5.90	6.59
	6.20	6.82	6.92	6.91	6.05	6.14	6.33	7.20	6.21	6.35	5.04
	6.23	.	.	.	.	.	.	.	.	.	.
AVE	6.18	6.48	6.83	6.69	6.07	5.98	6.51	6.90	5.89	6.11	5.71
1977 PLYMOUTH FURY 49S	7.13	7.18	7.96	7.46	7.61	8.56	.	8.28	.	8.49	.
	7.32	7.52	7.91	7.51	8.00	8.09	.	7.71	.	8.86	.
	.	.	.	7.64	7.45	.	.	.	.	.	.
AVE	7.22	7.35	7.94	7.54	7.68	8.32	.	7.98	.	8.67	.
1978 BUICK V6 TURBOCHARGE	8.81	8.60	8.70	9.17	9.12	9.42	7.59	9.34	7.78	8.11	7.06
	8.69	8.58	8.85	9.00	9.05	9.17	8.42	9.05	7.80	8.87	7.06
	8.69	.	.	.	.	.	.	.	.	.	.
AVE	8.73	8.59	8.77	9.08	9.08	9.29	7.98	9.19	7.79	8.47	7.06
1977 PLYMOUTH FURY CALIF	7.19	7.29	6.97	6.74	6.89	7.60	7.03	7.22	6.44	6.82	6.12
	7.29	7.52	6.88	7.09	6.81	7.29	6.60	7.32	5.96	6.70	6.18
	.	.	.	.	.	.	.	.	.	.	5.79
AVE	7.24	7.40	6.92	6.91	6.85	7.44	6.81	7.32	6.19	6.76	6.02
1978 CHEVROLET ST W-CALIF	6.91	6.90	7.20	7.39	7.47	7.57	7.39	7.79	6.78	6.89	6.10
	6.88	6.72	7.13	7.33	7.49	7.73	7.44	7.37	6.85	7.04	6.15
AVE	6.89	6.81	7.17	7.36	7.48	7.65	7.41	7.57	6.82	6.97	6.13
1978 FORD PINTO CAL 3 WAY	9.01	9.56	9.78	9.85	10.35	10.85	9.44	10.48	9.41	11.02	10.06
	9.91	9.26	9.81	10.18	10.96	11.23	10.02	10.80	9.78	11.07	9.93
	9.11	.	.	.	.	.	.	11.11	.	.	10.00
AVE	9.33	9.41	9.79	10.01	10.64	11.03	9.73	10.79	9.59	11.05	10.00
1978 VW RABBIT CAL FU-INJ	9.46	9.97	10.54	11.49	11.25	11.16	.	11.45	.	11.62	.
	9.28	10.09	10.43	10.98	11.18	11.68	.	10.81	.	11.21	.
AVE	9.37	10.03	10.48	11.23	11.22	11.41	.	11.12	.	11.41	.
1979 DODGE ASPEN CALIF.	8.00	7.96	8.65	8.50	8.69	8.90	8.62	8.80	8.25	8.72	8.03
	8.03	8.05	8.09	8.56	8.55	8.78	8.49	8.67	8.23	8.45	8.29
AVE	8.02	8.00	8.36	8.53	8.62	8.84	8.55	8.73	8.24	8.58	8.16
1980 MERCURY PROTOTYPE	.	7.57	8.46	8.72	9.21	9.12	8.70	9.11	8.30	9.32	8.19
	.	7.86	.	.	9.03	8.98	.	.	.	9.21	8.67
AVE	.	7.72	8.46	8.72	9.12	9.05	8.70	9.11	8.30	9.26	8.42
1980 BUICK REGAL PROTOTYP	.	9.81	10.21	10.67	10.73	11.07	10.05	10.88	9.53	11.14	9.23
	.	9.71	.	.	10.87	10.97	.	.	.	11.00	9.30
AVE	.	9.76	10.21	10.67	10.80	11.02	10.05	10.88	9.53	11.07	9.26
DATSUN PROTOTYPE	14.26	14.11	14.87	15.59	15.51	16.42	.	15.77	.	19.88	.
	14.28	14.31	15.02	15.49	15.36	16.22	.	15.44	.	15.62	.
	.	.	15.11	.	.	.	.	.	.	.	.
AVE	14.28	14.21	15.00	15.54	15.43	16.32	.	15.60	.	17.49	.

Sulfate Emission Test-Fuel Economy--

The fuel economy results shown in Table 96 for the SET procedure were somewhat poorer than those achieved with the HFET. This higher speed test with more accelerations would be expected to give poorer fuel economy results. The best fuel economy occurred most frequently at 80°F (27°C) rather than at 110°F (43°C). Again the use of the air conditioner reduced fuel economy.

TABLE 96 SULFATE EMISSION TEST - FUEL ECONOMY KM/L

TEMPERATURE F	0	40	80	80AC	110	110AC
(C)	(-18)	(4)	(27)	(27)	(43)	(43)
1972 CHEVROLET IMPALA	6.17	6.39	7.38	6.92	7.23	7.04
	6.10	6.24	6.96	6.41	6.59	5.47
AVE	6.14	6.31	7.17	6.66	6.91	6.25
1974 CHEVROLET IMPALA	5.83	6.05	6.56	.	5.93	.
	6.14	6.09	6.72	.	7.31	.
AVE	5.98	6.07	6.64	.	6.62	.
1977 HONDA CIVIC 49 STATE	10.39	11.75	12.29	.	12.33	.
	10.34	11.86	12.47	.	11.39	.
AVE	10.36	11.81	12.38	.	11.86	.
1977 FORD LTD 49 STATE	5.46	6.29	5.77	6.20	6.03	5.28
	5.81	6.26	6.08	6.21	5.97	4.64
	5.96	.	.	.	.	.
AVE	5.74	6.28	5.92	6.21	6.00	4.96
1977 PLYMOUTH FURY 49S	6.50	7.00	7.34	.	7.28	.
	6.83	7.14	7.45	.	7.45	.
AVE	6.67	7.07	7.40	.	7.37	.
1978 BUICK V6 TURBOCHARGE	7.78	7.70	8.35	6.52	6.70	6.17
	7.75	7.70	8.09	7.48	6.67	6.07
	7.64	.	.	.	.	.
AVE	7.72	7.70	8.22	7.00	6.68	6.12
1977 PLYMOUTH FURY CALIF	6.38	6.13	6.70	6.09	5.94	5.50
	6.24	6.14	6.18	5.95	5.83	5.36
	.	.	.	.	.	5.09
AVE	6.31	6.13	6.44	6.02	5.89	5.32
1978 CHEVROLET ST W-CALIF	6.31	6.57	6.96	6.55	6.51	5.60
	6.17	6.69	7.01	6.27	6.53	5.58
AVE	6.24	6.63	6.96	6.41	6.52	5.59
1978 FORD PINTO CAL 3 WAY	8.11	8.45	9.55	8.21	10.41	8.94
	8.19	10.03	10.14	9.08	9.47	8.49
	7.94	.	.	.	.	.
AVE	8.08	9.24	9.85	8.65	9.94	8.71
1978 VW RABBIT CAL FU-INJ	8.54	9.56	10.30	.	10.26	.
	8.37	9.45	10.56	.	9.97	.
AVE	8.46	9.50	10.43	.	10.11	.
1979 DODGE ASPEN CALIF.	7.26	8.02	8.13	7.88	7.93	7.32
	7.33	7.53	8.02	7.81	7.77	7.67
AVE	7.31	7.77	8.07	7.85	7.85	7.50
1980 MERCURY PROTOTYPE	.	7.24	8.03	7.77	8.26	7.42
	.	7.24	7.89	7.77	8.14	7.61
AVE	.	7.24	7.96	7.77	8.20	7.51
1980 BUICK REGAL PROTOTYP	.	9.31	10.13	8.98	10.19	8.33
	.	9.31	9.87	8.98	10.22	8.37
AVE	.	9.31	10.00	8.98	10.20	8.35
DATSUN PROTOTYPE	12.02	13.11	14.53	.	9.44	.
	12.10	13.15	14.07	.	13.73	.
	12.06	13.32	14.30	.	11.59	.
AVE	12.06	13.19	14.30	.	11.59	.

New York City Cycle-Fuel Economy--

Table 97 shows that this procedure of idle and sharp accelerations had a marked effect on fuel economy. The fuel economy fell more than 50% from that obtained during the HFET and was poorer than that obtained during the cold transient phase of the FTP.

TABLE 97 NEW YORK CITY CYCLE - FUEL ECONOMY KM/L

TEMPERATURE F	20	60	80	80AC	110	110AC
(C)	(-7)	(16)	(27)	(27)	(43)	(43)
1977 HONDA CIVIC 49 STATE	5.40	6.19	6.43	.	6.45	.
	6.11	6.51	6.57	.	6.54	.
AVE	5.75	6.35	6.50	.	6.49	.
1978 BUICK V6 TURBOCHARGE	3.55	3.82	3.78	3.00	2.55	2.22
	3.58	3.65	3.75	3.11	2.99	2.66
AVE	3.57	3.74	3.77	3.06	2.77	2.44
1978 FORD PINTO CAL 3 WAY	3.78	4.12	4.69	3.93	4.17	3.81
	3.66	4.28	5.00	4.34	4.43	1.27
AVE	3.72	4.20	4.85	4.13	4.30	2.54
1978 VW RABBIT CAL FU-INJ	4.46	4.95	5.12	.	5.17	.
	4.42	5.06	5.47	.	5.02	.
AVE	4.44	5.01	5.29	.	5.09	.
1979 DODGE ASPEN CALIF.	3.53	3.84	3.92	3.71	3.75	3.58
	3.63	3.57	3.74	3.59	3.76	3.70
AVE	3.58	3.71	3.83	3.65	3.75	3.64
1980 MERCURY PROTOTYPE	2.50	3.25	3.45	3.42	3.48	2.96
	2.57	3.25	3.52	3.42	3.57	3.39
AVE	2.53	3.25	3.49	3.42	3.53	3.17
1980 BUICK REGAL PROTOTYP	4.46	4.95	4.48	4.10	5.09	4.20
	4.74	4.95	4.59	4.10	4.96	4.47
AVE	4.60	4.95	4.54	4.10	5.02	4.33
DATSUN PROTOTYPE	6.32	6.68	6.69	.	5.89	.
	6.21	6.46	6.87	.	6.09	.
AVE	6.26	6.57	6.78	.	5.99	.

Federal Short Cycle-Fuel Economy--

The results listed in Table 98 show that the FSC, with a warmed up engine, produced only a small temperature effect on fuel economy. The best fuel economies were obtained at 80°F (27°C).

TABLE 98 FEDERAL SHORT CYCLE - FUEL ECONOMY KM/L

TEMPERATURE F		0	40	80	110
	(C)	(-18)	(4)	(27)	(43)
1972 CHEVROLET IMPALA		5.29	5.92	6.20	6.28
		5.38	5.41	6.60	5.97
	AVE	5.34	5.66	6.40	6.12
1974 CHEVROLET IMPALA		5.61	5.58	5.84	5.72
		5.49	5.63	6.19	5.86
	AVE	5.55	5.61	6.02	5.79
1977 FORD LTD		5.98	5.03	5.89	5.82
		5.90	6.29	6.29	5.40
		5.80	.	.	.
	AVE	5.90	5.66	6.09	5.61
1977 PLYMOUTH FURY 49S		6.55	6.69	7.65	6.67
		6.08	7.12	7.67	7.02
	AVE	6.32	6.90	7.66	6.85
1977 PLYMOUTH FURY CALIF		5.68	5.81	6.48	5.25
		5.62	5.77	6.22	5.53
	AVE	5.65	5.79	6.35	5.39
1978 CHEVROLET ST W-CALIF		5.70	5.97	6.65	4.27
		5.93	5.96	6.45	6.14
	AVE	5.81	5.97	6.55	5.21

CATALYST TEMPERATURES

Light-Off Time - Seconds

Table 99 gives the light-off times for the catalyst equipped cars. The "Light-Off Time" was defined as the time in seconds from the start of the cold transient phase of the FTP until the temperature of the gases leaving the catalyst exceeded those entering. The catalyst had to be working for this condition to exist.

The Datsun Prototype had the shortest light-off times at most temperatures. Other cars with fast light-off times at low temperatures were the 1977 (49 State) Plymouth, the 1979 Dodge Aspen and the 1980 Mercury Prototype. Gas temperatures were measured by thermocouples in the gas streams except for the 1979 Dodge and three prototype cars. For these cars, surface thermocouples were used. This was done to keep from drilling holes in the exhaust pipes of the manufacturers' supplied cars. Catalyst light-off times varied from 67 to 419 seconds.

TABLE 99 LIGHT OFF TIME, SECONDS FEDERAL TEST PROCEDURE

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1977 FORD LTD 49 STATE	960. 949. 957.	962. 930 910	994. 950. 950.	603. 603.	653. 609. 609.	666. 640. 640.	690. 665. 665.	721. 723. 723.	722. 729. 729.	686. 689. 669.	716. 746. 746.
1977 PLYMOUTH FURY 49S	467. 471. 471.	423. 415. 415.	444. 369. 389.	616. 457. 468.	458. 433. 497.	517. 463. 463.		552. 478. 478.		521. 549. 549.	
1976 BUICK V6 TURBOCHARGE	681. 679. 695.	633.	543. 610.	566. 530.	592. 562.	573. 551.	596. 569.	522. 525.	579. 593.	537. 644.	652 629.
1977 PLYMOUTH FURY CALIF	847. 826.	811. 804.	869. 832.	675. 699	722. 747	727 733	815 796	799 761.	824 796.	710 667	727 732. 753
1976 CHEVROLET ST W-CALIF	971. 903.	836. 864.	804. 831.	796. 786.	776. 769.	761. 753.	813. 814.	775. 766.	853. 828.	800. 782.	837. 809.
1978 FORD PINTO CAL 3 WAY	744. 670. 785.	998. 526.	965. 1008.	824. 815.	704. 592.	601. 628.	697. 566.	894. 987. 917.	559. 756.	870. 933.	1124. 875. 812.
1976 VW RABBIT CAL FU-INJ	791. 820.	774. 760.	737 745.	666. 690.	667. 683.	652. 648		636. 619.		655. 639.	
1979 DODGE ASPEN CALIF.	414. 355.	365. 365.	349. 366.	373 368.	359 384.	426. 397.	441. 420.	429. 435.	411. 422.	422. 438.	422. 430.
1980 MERCURY PROTOTYPE		361. 363.	375.	352.	312.	409. 333.	415.	407.	427.	395. 412.	423. 436.
1980 BUICK REGAL PROTOTYPE		506. 503.	514.	511.	507.	498. 519.	570.	530.	576.	531. 519.	553. 560.
DATSUN PROTOTYPE	269. 276.	292. 300.	299. 256. 275.	285 282.	340. 310.	341. 309.		349. 328.		397. 346.	

Light-Off Temperature - Degrees F

Table 100 gives the light-off temperatures associated with the light-off times. This temperature varied from car to car but usually ranged from about 400 to 1100°F (204 to 593°C). Temperatures of the 1979 Dodge and three prototype cars cannot be considered representative of the exhaust gas temperatures because of the use of surface thermocouples. However, trends in temperature direction were observed.

TABLE 100 LIGHT OFF TEMPERATURE - F FEDERAL TEST PROCEDURE

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1977 FORD LTD 49 STATE	266. 283. 280.	246. 294	312. 300.	141.	130. 139.	133. 144.	122. 137.	124. 133.	130. 133.	138. 139.	138. 144.
1977 PLYMOUTH FURY 49S	79. 78.	128. 115.	128. 121.	216. 130. 125.	123. 136.	187. 173.		120. 130.		129. 129.	
1978 BUICK V6 TURBOCHARGE	315. 345. 311.	321.	344. 320.	332. 339.	326. 332.	328. 334.	330. 337.	347. 347.	338. 338.	344. 327.	324. 330.
1977 PLYMOUTH FURY CALIF	133. 131.	142. 145.	121. 142.	133. 122	106. 117.	122 120	116 115	122 126.	118 125.	119 134	118. 117. 118
1978 CHEVROLET ST W-CALIF	276. 226.	319. 319.	310. 310.	314. 310.	315. 314.	326. 319.	331. 329.	310. 324.	321. 322.	310. 309.	327. 327.
1978 FORD PINTO CAL 3 WAY	120. 120. 130.	250. 189.	294. 272.	117. 126.	125. 140.	151. 169.	135. 160.	311. 260. 307.	156. 187.	329. 318.	245. 308. 190.
1978 VW RABBIT CAL FU-INJ	151. 140.	132. 131.	131. 133.	139. 137.	141. 138.	144. 143.		153. 150.		151. 158.	
1979 DODGE ASPEN CALIF.	75. 67.	75. 66.	71. 75.	83 72.	76. 69.	96. 86.	99. 107.	100. 103.	76. 80.	99. 102.	93. 98.
1980 MERCURY PROTOTYPE		336. 316.	310.	195.	192.	279. 200.	302.	306.	306.	311. 311.	315. 305.
1980 BUICK REGAL PROTOTYPE		408. 399.	407.	394.	398.	407. 404.	380.	401.	388.	419. 405.	408. 403.
DATSUN PROTOTYPE	169. 165.	122. 191.	138. 129. 146.	163. 165.	198. 183.	198. 191.		198. 192.		209. 197.	

Maximum Catalyst Temperatures

Federal Test Procedure--

Table 101 gives the maximum exhaust gas temperatures observed after the catalyst for the FTP. After monitoring light-off conditions at the fastest recording rate, the instrument was switched to record at one minute intervals. Because many accelerations and decelerations took less than one minute, it is quite possible that true maximum temperatures were not observed. With this limitation, the data in Table 101 and the following four tables should be considered as indicative of trends only.

For each vehicle, the catalyst seemed to operate at a characteristic maximum exhaust gas temperature independent of the ambient temperature. It is generally true that use of the air conditioners resulted in higher maximum temperatures.

TABLE 101 CATALYST TEMPERATURE, MAX, FEDERAL TEST PROCEDURE

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1977 FORD LTD 49 STATE	1053. 1030. 1026.	1072. 1021.	1056. 1032.	1109. 1065.	1073. 1074.	1078. 1040.	1083. 1109.	1052. 1080.	1093. 1106.	1055. 1085.	1089. 1069.
1977 PLYMOUTH FURY 495	860. 993.	888. 869.	980. 847.	917. 969. 989.	964. 969.	956. 963.		967. 967.		944. 955.	
1978 BUICK V6 TURBOCHARGE	845. 1054. 837.	860.	836. 950.	866.	864. 850.	888. 898.	879. 892.	865. 838.	944. 931.	1079. 1006.	1100. 1056.
1977 PLYMOUTH FURY CALIF	1201. 1198.	1107. 1162.	1060. 1170.	1059. 1077.	1053. 1142.	1125 1098	1144 1134	1170 1157.	1192 1190.	1151 1237	1243 1037. 1354
1978 CHEVROLET ST #-CALIF	971. 972.	863. 892.	922. 869.	861. 853.	861. 840.	850. 846.	905. 893.	909. 878.	978. 938.	967. 979.	990. 1029.
1978 FORD PINTO CAL 3 WAY	1140. 1038. 1106.	894. 1007.	967. 1015.	1167. 1091.	1111. 1009.	1087. 951.	1085. 1036.	922. 987. 994.	1041. 1041.	965. 963.	1127. 922. 1141.
1978 VW RABBIT CAL FU-INJ	1149. 1168.	1145. 1143.	1133. 1131.	1114. 1113.	1105. 1101.	1102. 1094.		1104. 1069.		1026. 1028.	
1979 DODGE ASPEN CALIF.	1162. 1164.	1161. 1115.	1138. 1119.	1005. 998.	994 978.	956. 956.	938. 954.	806. 811.	827. 850.	850. 866.	864. 863.
1980 MERCURY PROTOTYPE		462. 476.	466.	461.	452.	441. 448.	443.	460.	475.	460. 458.	488. 464.
1980 BUICK REGAL PROTOTYP		561. 555.	574.	562.	568.	559. 564.	608.	562.		576. 590.	618. 626.
DATSUN PROTOTYPE	651. 665.	638. 618.	582. 605. 576.	616. 606.	625. 612.	627. 626.		643. 645.		677. 683.	

Highway Fuel Economy Test--

The maximum exhaust gas temperatures after the catalyst for the HFET are given in Table 102. The differences in exhaust gas temperatures between cars are greater than those between ambient test temperatures and also between the HFET and FTP procedures.

TABLE 102 CATALYST TEMPERATURE, MAX,HIGHWAY FUEL ECONOMY TEST

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1977 FORD LTD 49 STATE	1115. 1137. 1130.	1157. 1094.	1138. 1117.	1235. 1148.	1221. 1198.	1253. 1207.	1197. 1227.	1246. 1210.	1213. 1217.	1118. 1153.	1177. 1153.
1977 PLYMOUTH FURY 49S	1020. 1037.	999. 904.	935. 934.	1022. 1027. 1074.	1018. 1025.	978. 1002.		980. 1024.		941. 966.	
1978 BUICK V6 TURBOCHARGE	748. 759. 741.	864.	833. 885.	884.	889. 885.	885. 925.	947. 907.	964. 893.	1023. 972.	1290. 1136.	1269. 1209.
1977 PLYMOUTH FURY CALIF	921. 912.	965. 894.	974. 953.	991 986.	1013. 1048.	1010 1039	1039 1149	1086 1070.	1287 1196.	1374 1462	1337 1334. 1377
1978 CHEVROLET ST W-CALIF	911. 933.	916. 946.	928. 930.	956. 938.	949. 941.	955. 962.	980. 960.	975. 958.	1034. 1023.	1071. 1049.	1158. 1124.
1978 FORD PINTO CAL 3 WAY	972. 890. 928.	930. 1066.	904. 1064.	1041. 978.	940. 894.	939. 899.	1076. 955.	937. 896. 915.	1050. 995.	926. 954.	991. 1101.
1976 VW RABBIT CAL FU-INJ	1173. 1184.	1153. 1146.	1145. 1134.	1133. 1151.	1163. 1151.	1154. 1141.		1131. 1111.		1050. 1084.	
1979 DODGE ASPEN CALIF.	821. 816.	834. 836.	835. 800.	851 851.	858 859.	861. 853.	867. 858.	866. 871.	885. 888.	866. 898.	915. 903.
1980 MERCURY PROTOTYP		495. 484.	474.	457.	459.	474. 494.	487.	483.	502.	500. 495.	544. 504.
1980 BUICK REGAL PROTOTYP		604. 653.	661.	608.	683.	688. 694.	730.	691.		709. 703.	745. 751.
DATSUN PROTOTYPE	513. 504.	535. 530.	542. 544. 532.	602. 602.	626. 585.	615. 604.		634.		738. 716.	

Sulfate Emission Test--

Table 103 shows the maximum exhaust gas temperature out of the catalyst for the SET procedure.

TABLE 103 CATALYST TEMPERATURE, MAX. SULFATE EMISSION TEST

TEMPERATURE F	0	40	80	80AC	110	110AC
(C)	(-18)	(4)	(27)	(27)	(43)	(43)
1977 FORD LTD 49 STATE	1089.	1098.	1199.	1171.	1095.	1137.
	1088.	1070.	1164.	1184.	1130.	1124.
	1080.					
1977 PLYMOUTH FURY 49S	953.	989.	982.		977.	
	1008.	925.	1015.		979.	
1978 BUICK V6 TURBOCHARGE	767.	883.	921.	986.	1241.	1220.
	782.	958.	964.	952.	1156.	1159.
	799.					
1977 PLYMOUTH FURY CALIF	1029.	1027.	1133	1128	1356	1286
	1000.	1020.	1082	1200	1441	1318.
						1336
1978 CHEVROLET ST W-CALIF	936.		973.	994.	1092.	1119.
	951.	938.	946.	980.	1064.	1135
1978 FORD PINTO CAL 3 WAY	1029.	958.	1068.	1114.	976.	
	965.	1054.	925.	979.	1035.	1050.
	966.					1129.
1978 VW RABBIT CAL FU-INJ	1150.	1133.	1119.		1045.	
	1182.	1112.	1119.		1058.	
1979 DODGE ASPEN CALIF.	824.	832.	863.	868.	904.	922.
	825.	830.	861.	874.	908.	905.
1980 MERCURY PROTOTYPE		517.	486.	493.	509.	554.
			506.		516.	535.
1980 BUICK REGAL PROTOTYP		651.	665.	714.	685.	731.
			677.		682.	732.
DATSUN PROTOTYPE	591.	607.	671		758.	
	589.	608.	670.		737.	
		600.				

New York City Cycle--

The maximum exhaust gas temperatures from the catalysts for the NYCC are given in Table 104. In essentially every test, the temperatures reported for this test were lower than for any of the three preceding tests. This result was probably due to the great amount of idle time included in this procedure.

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TABLE 104 CATALYST TEMPERATURE, MAX, NEW YORK CITY CYCLE

TEMPERATURE F (C)	20 (-7)	60 (16)	80 (27)	80AC (27)	110 (43)	110AC (43)
1978 BUICK V6 TURBOCHARGE	 767.	776.	778. 805.	904. 861.	1162. 1037.	1141. 1107.
1978 FORD PINTO CAL 3 WAY	816. 841.	867. 799.	843. 790.	893. 828.	1043. 997.	 967. 1107.
1978 VW RABBIT CAL FU-INJ	878. 874.	845. 850.	857. 830.		792. 806.	
1979 DODGE ASPEN CALIF.	584. 597.	616 616.	629. 628.	625. 636.	665. 677.	667. 671.
1980 MERCURY PROTOTYPE	510. 452.	409.	416. 394.	402.	437. 421.	466. 432.
1980 BUICK REGAL PROTOTYP	513. 508.	543.	548. 550.	569.	579. 568.	597. 596.
DATSUN PROTOTYPE	507. 500.	564. 568.	581. 582.		663. 663.	

Federal Short Cycle--

The data in Table 105 show that the FSC maximum exhaust gas temperatures were lower than those found in the SET procedure. This result was probably due to the short duration of the FSC procedure and the moderate accelerations.

TABLE 105 CATALYST TEMPERATURE, MAX, FEDERAL SHORT CYCLE

TEMPERATURE F (C)	0 (-18)	40 (4)	80 (27)	80AC (27)	110 (43)
1977 FORD LTD 49 STATE	847. 853. 877.	935. 901.	864. 884.	850.	767. 876.
1977 PLYMOUTH FURY 49S	651. 740.	668. 585.	638. 660.		676. 671.
1977 PLYMOUTH FURY CALIF	744. 697.	686. 702.	736 783		1343 1296
1978 CHEVROLET ST W-CALIF	732. 803.	818. 807.	834. 841.		983. 947.

Minimum Catalyst Temperatures

The next five tables show the minimum exhaust gas temperatures out of the catalysts. Since every test starts at some particular ambient temperature, the minimum temperature is defined as the lowest recorded catalyst-out temperature after that temperature had reached a peak not necessarily the maximum.

Federal Test Procedure--

Table 106 lists the minimum exhaust gas temperatures observed for the FTP. The minimums did not appear to depend on the ambient temperature. Air conditioner operation usually raised the minimums.

TABLE 106 CATALYST TEMPERATURE, MIN, FEDERAL TEST PROCEDURE

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1977 FORD LTD 49 STATE	847. 828. 825.	852. 818.	878. 822.	897.	906. 883.	901. 891.	907. 913.	870. 686.	901. 905.	859. 869.	874. 876.
1977 PLYMOUTH FURY 49S	563. 467.	674. 602.	723. 597.	714. 743. 718.	437. 588.	528. 456.		597. 575.		515. 545.	
1978 BUICK V6 TURBOCHARGE	703. 690. 655.	723.	712. 613.	565.	590. 742.	792. 550.	592. 568.	731. 711.	578. 592.	773. 640.	648. 626.
1977 PLYMOUTH FURY CALIF	706. 758.	720. 747.	752. 760.	756 761.	726. 801.	643 792	665 787	783 777.	712 811.	751 619	843 972. 956
1978 CHEVROLET ST W-CALIF	616. 630.	639. 654.	725. 650.	759. 743.	654. 638.	649. 641.	790. 677.	772. 667.	852. 803.	797. 780.	836. 807.
1978 FORD PINTO CAL 3 WAY	719. 614. 622.	629. 676.	599. 669.	722. 709.	698. 592.	606. 587.	691. 566.	635. 637. 639.	711. 681.	693. 683.	753. 688. 755.
1978 VW RABBIT CAL FU-INJ	787. 816.	771. 857.	736. 844.	819. 828.	811. 824.	826. 805.		817. 799.		812. 813.	
1979 DODGE ASPEN CALIF.	559. 573.	548. 622.	598. 603.	601 622.	608 620.	619. 620.	633. 634.	625. 613.	640. 635.	667. 656.	666. 650.
1980 MERCURY PROTOTYPE		387. 410.	404.	365.	370.	374. 386.	360.	392.	421.	392. 395.	417. 399.
1980 BUICK REGAL PROTOTYP		456. 389.	458.	464.	470.	471. 482.	512.	478.		502. 504.	528. 536.
DATSUN PROTOTYPE	515. 517.	498. 504.	515. 512. 508.	503. 495.	542. 549.	564. 559.		585. 570.		513. 618.	

Highway Fuel Economy Test--

The HFET minimum exhaust gas temperatures after the catalyst (Table 107) are equal to or up to 200°F (111°C) higher than those found on the FTP.

TABLE 107 CATALYST TEMPERATURE, MIN,HIGHWAY FUEL ECONOMY TEST

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1977 FORD LTD 49 STATE	1004. 999. 1000.	1031. 940.	1008. 968.	1047. 1020.	1096. 1050.	1127. 1100.	1082. 1092.	1048. 1073.	1087. 1087.	1002. 1104.	1085. 1025.
1977 PLYMOUTH FURY 49S	817. 856.	839. 772.	801. 789.	858. 847. 933.	847. 824.	807. 833.		818. 887.		862. 836.	
1978 BUICK V6 TURBOCHARGE	686. 689. 673.	831.	746. 808.	810.	769. 782.	832. 866.	874. 844.	903. 794.	950. 898.	1181. 1022.	1135. 1022.
1977 PLYMOUTH FURY CALIF	765. 765.	751. 724.	812. 807.	789 864.	875. 889.	806 872	855 917	889 885.	936 931.	1027 1340	1006 1052. 1103
1978 CHEVROLET ST W-CALIF	849. 864.	860. 884.	834. 844.	884. 859.	887. 880.	864. 847.	878. 889.	847. 812.	978. 914.	985. 978.	1042. 1043.
1978 FORD PINTO CAL 3 WAY	865. 773. 798.	817. 940.	796. 850.	853. 848.	829. 786.	821. 778.	917. 837.	835. 813. 815.	900. 856.	804. 834.	870. 888.
1978 VW RABBIT CAL FU-INJ	1073. 1081.	1045. 1045.	1050. 1032.	1036. 1058.	1055. 1054.	1058. 1045.		1043. 1027.		955. 988.	
1979 DODGE ASPEN CALIF.	676. 675.	653. 690.	647. 679.	758 697.	699 766.	727. 736.	732. 741.	720. 726.	720. 702.	786. 783.	789. 768.
1980 MERCURY PROTOTYPE		399. 405.	416.	380.	384.	395. 389.	405.	411.	438.	440. 439.	480. 450.
1980 BUICK REGAL PROTOTYP		549. 517.	565.	565.	565.	589. 598.	631.	573.		599. 604.	648. 645.
DATSUN PROTOTYPE	462. 466.	494. 485.	502. 503. 491.	552. 530.	577. 538.	569. 555.		566.		650. 639.	

Sulfate Emission Test--

The results of the SET minimum exhaust gas temperatures after the catalyst are given in Table 108.

TABLE 108 CATALYST TEMPERATURE, MIN. SULFATE EMISSION TEST

TEMPERATURE F (C)	0 (-18)	40 (4)	80 (27)	80AC (27)	110 (43)	110AC (43)
1977 FORD LTD 49 STATE	885. 864. 856.	901. 870.	947. 941.	926. 951.	892. 906.	907. 902.
1977 PLYMOUTH FURY 49S	742. 808.	724. 680.	787. 773.		799. 816.	
1978 BUICK V6 TURBUCHARGE	662. 715. 709.	760. 857.	838. 854.	856. 849.	1067. 963.	1049. 1022.
1977 PLYMOUTH FURY CALIF	731. 719.	793. 780.	828 825	820 833	1015 990	1007 1110. 1118
1978 CHEVROLET ST W-CALIF	706. 755.	764.	766. 758.	799. 770.	918. 893.	961. 999.
1978 FORD PINTO CAL 3 WAY	835. 742. 765.	776. 839.	752. 742.	881. 813.	788. 792.	834. 955.
1978 VW RABBIT CAL FU-INJ	906. 930.	885. 878.	891. 833.		842. 868.	
1979 DODGE ASPEN CALIF.	589. 608.	622. 622.	647. 653.	655. 672.	707. 705.	713. 689.
1980 MERCURY PROTOTYPE		408.	384. 379.	403.	417. 420.	434. 424.
1980 BUICK REGAL PROTOTYP		490.	516. 520.	548.	524. 543.	559. 566.
DATSUN PROTOTYPE	491. 490.	525. 525. 517.	587 574.		644. 645.	

New York City Cycle--

The minimum exhaust gas temperatures out of the catalyst for the NYCC are given in Table 109.

Federal Short Cycle--

The results of the FSC minimum exhaust gas temperatures after the catalyst are presented in Table 110.

TABLE 109 CATALYST TEMPERATURE, MIN, NEW YORK CITY CYCLE

TEMPERATURE F (C)	20 (-7)	60 (16)	80 (27)	80AC (27)	110 (43)	110AC (43)
1978 BUICK V6 TURBOCHARGE	726.	730.	737. 761.	820. 759.	1054. 969.	996. 992.
1978 FORD PINTO CAL 3 WAY	642. 712.	737. 681.	697. 652.	727. 662.	911. 834.	723. 1011.
1978 VW RABBIT CAL FU-INJ	751. 752.	748. 755.	761. 744.		692. 707.	
1979 DODGE ASPEN CALIF.	499. 503.	587 542.	588. 561.	588. 570.	646. 618.	626. 624.
1980 MERCURY PROTOTYPE	422. 399.	334.	342. 303.	347.	398. 368.	414. 382.
1980 BUICK REGAL PROTOTYP	430. 422.	459.	474. 474.	490.	503. 496.	511. 513.
DATSUN PROTOTYPE	490. 485.	544. 546.	525. 560.		643. 642.	

TABLE 110 CATALYST TEMPERATURE, MIN, FEDERAL SHORT CYCLE

TEMPERATURE F (C)	0 (-18)	40 (4)	80 (27)	80AC (27)	110 (43)
1977 FORD LTD 49 STATE	840. 831. 867.	886. 854.	809. 865.	815.	750. 798.
1977 PLYMOUTH FURY 49S	599. 716.	666. 556.	609. 633.		651. 665.
1977 PLYMOUTH FURY CALIF	695.	606. 647.	733 709		1215 1183
1978 CHEVROLET ST *-CALIF	683. 802.	745. 736.	764. 763.		923. 887.

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DRIVEABILITY

The cars used in this program were a mixture of new, rented, or EPA supplied cars. The rented cars had all accumulated at least 10,000 miles. The new and rented cars were tuned to manufacturers' specifications with new spark plugs, points and condensers, etc. The carburetors were not overhauled. The EPA supplied cars (1979 Dodge and three prototypes) after normal inspections were tested in the as-received condition.

Table 111 lists the average driveability ratings for each car at each test temperature. These ratings were based on the Coordinating Research Council system of demerits (22). In this system, a stall at idle has a demerit of 8 while a stall during running has a demerit of 32. Hesitation, stumble and surge have lesser demerits, depending on their severity. Most of the driveability problems were experienced during the cold transient phase of the FTP.

The vehicles differed substantially in their driveability characteristics. Furthermore, within a given vehicle, driveability varied with ambient temperature. In several cases, poor driveability contributed to the high exhaust gas emissions noted. In other cases, the high emissions encountered may have been due to reduced catalyst activity rather than driveability problems.

TABLE 111 AVERAGE DRIVEABILITY RATINGS

TEMPERATURE F (C)	0 (-18)	20 (-7)	40 (4)	60 (16)	70 (21)	80 (27)	80AC (27)	90 (32)	90AC (32)	110 (43)	110AC (43)
1972 CHEVROLET IMPALA	45	16	3	12	18	51	41	32	48	17	33
1974 CHEVROLET IMPALA	70	30	16	19	1	24	*	10	*	1	*
1977 HONDA CIVIC 49 STATE	92	90	90	91	11	0	*	0	*	12	*
1977 FORD LTD 49 STATE	89	44	32	9	18	10	9	0	9	7	29
1977 PLYMOUTH FURY 49S	39	10	1	95	30	82	*	28	*	1	*
1978 BUICK V6 TURBOCHARGE	79	37	27	16	6	1	0	0	0	26	21
1977 PLYMOUTH FURY CALIF	4	0	0	13	20	1	1	3	1	0	4
1978 CHEVROLET ST W-CALIF	72	12	1	9	1	2	10	9	10	2	4
1978 FORD PINTO CAL 3 WAY	6	22	1	18	67	27	43	9	27	47	59
1978 VW RABBIT CAL FU-INJ	45	5	0	0	0	0	*	0	*	0	*
1979 DODGE ASPEN CALIF	11	3	2	1	30	28	17	2	1	2	5
1980 MERCURY PROTOTYPE	*	1	1	18	18	9	0	1	0	18	18
1980 BUICK REGAL PROTOTYPE	*	0	0	3	1	8	1	1	0	1	7
DATSUN PROTOTYPE	143	55	26	0	0	2	*	1	*	1	*

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